

Preliminary Feasibility Assessment For A Biomass Power Plant in Northern Arizona

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I. EXECUTIVE SUMMARY AND FINDINGS

The Greater Flagstaff Forests Partnership (GFFP) is an alliance of 25, academic, business, environmental and governmental organizations dedicated to researching and demonstrating approaches to forest ecosystem restoration in the ponderosa pine forests surrounding Flagstaff, Arizona.

GFFP's three primary goals are:

- Restore natural ecosystem structures, function, and composition of ponderosa pine forests;
- Manage forest fuels to reduce the probability of catastrophic fire;
- Research, test, develop, and demonstrate key ecological, economic, and social dimensions of restoration efforts.

The Greater Flagstaff Forests Partnership (GFFP) retained TSS Consultants (TSS) to conduct a preliminary feasibility assessment of the viability of locating a biomass power plant in northern Arizona. This assessment addressed the key project viability issues to indicate whether a proposed plant would be economical and environmentally viable. This type of assessment would be necessary prior to proceeding with the allocation of high-risk capital to develop, finance, construct and operate a proposed facility.

If developed, a new biomass power plant in northern Arizona would create a new market demand for hazardous forest fuels removed as a byproduct of forest restoration projects, reduce air quality and visibility problems in the region by reducing the hazardous fuels that burn in wildfires, reduce the costs and losses from wildfire and create new jobs and economic development for the local communities.

The target study site for this assessment was a 20 acre industrial parcel located at Bellemont, Arizona.

The findings of this assessment related to each project viability issue are as follows:

1. ***Is there an available long-term supply of biomass that is economically and environmentally viable?***

Finding: There is adequate forest sourced fuel available on a long-term basis for supplying a new 5 megawatt (MW) biomass power plant. However, in order to deliver fuel in an economic range – below \$40/Bone Dry Ton (BDT) it would be necessary for the respective landowners to pay part of the delivered costs, to reduce the delivered cost of fuel \$10 to \$30/BDT. For the project to be financed,

up to 70% of the fuel will have to be placed under long-term fuel procurement contracts (preferably 10 years).

2. ***Are there viable electrical power plant technologies available for a proposed 5 MW biomass power plant?***

Finding: There are commercially available biomass power plant boilers and turbines that could be utilized for the proposed application at the Bellemont site in northern Arizona. There are also newer biomass technologies, including gasification technologies, that produce electricity that are near commercialization, which should be considered for future applications that could use forest fuels in northern Arizona.

3. ***Is it probable that a proposed biomass power plant can be permitted at the Bellemont site and the proposed plant's environmental impacts can be mitigated to the satisfaction of the regulatory agencies, citizens, communities and other stakeholders?***

Finding: The Bellemont, site chosen by GFFP appears to be permit-able and any environmental impacts, such as air quality and water impacts can be mitigated in a manner that should be acceptable to the regulatory agencies, citizens, communities and other stakeholders. The major issue is the consumptive use of water by a proposed biomass power plant. Projected water use is from 1.2 to 11 acre feet per year depending on the technology used in a new power plant. Water may be available from Camp Navajo, who indicated they will be drilling a new deep water well, and may have surplus water available for the project. In the worst economic case, a new deep water well would have to be drilled for the biomass power plant at a cost of \$1 million-plus.

4. ***Does the current electrical market offer viable rates and revenue to justify the capital investment?***

Finding: The Arizona electrical marketplace wholesale rates are in the \$0.02 to \$0.03 cents/kilowatt hour (kWh) range, significantly below the \$0.22 cents/kWh power purchase agreement needed for a proposed biomass power plant in northern Arizona. Although Arizona has adopted an Environmental Portfolio Standard (EPS) that requires a small percentage of the electricity delivered to consumers be solar, landfill gas, wind or biomass, the EPS is not structured to support new biomass combustion systems. The current Arizona EPS is a program that mandates and primarily supports new solar electric (photovoltaic) and solar thermal systems. This is an excellent first step in developing an electrical EPS. If the public benefits justify, the EPS could be expanded to include other public benefits by supporting development of one or two new biomass power plants in northern Arizona. This would create new demand for forest fuels to reduce the air quality impacts in the Grand Canyon region and reduce the costs and losses from wildfires.

5. ***Is the proposed biomass plant economically viable with projected Return on Investment (ROI) that will attract equity and debt financing?***

Finding: Under current market conditions in northern Arizona, a proposed biomass power plant would not attract the equity and debt financing necessary to develop and operate the facility. The preliminary financial projections developed in this assessment show that the capital costs, operating costs, and delivered biomass fuel costs are too high relative to projected revenues and return on investments (ROI) to attract equity and debt financing from private financial markets.

6. ***Is the proposed biomass power project sufficiently viable to attract a developer, development team and credible operating staff that will satisfy the financial markets?***

Finding: Based on the analyses as referenced in the findings above, the project is not currently viable to attract a development team and satisfy the financial markets to provide the equity and debt financing needed for the project. In order for the project to become attractive to the private markets, one or more of the following would have to occur:

- Expansion of the EPS to include the proposed biomass power plant;
- Public landowners absorb some of the delivered fuel costs to the proposed biomass power plant;
- Acquire a direct federal and/or state funding grant for part of the capital investment for the plant.

7. ***What would be needed in the market place to support a new biomass power plant in northern Arizona?***

Finding: Critical elements for a successful project would require one or more of the following:

- A 20-year power sales contract of \$0.22/kWh with a credit worthy utility or power purchaser. Currently the Arizona EPS is subsidizing solar photovoltaic technologies with projected costs around \$0.22+/kWh for generating electricity. However, neither the EPS mandate nor the EPS subsidy is currently available that would support new biomass power plants.
- A U.S. Department of Energy, U.S. Department of Agriculture or other government agency grant for 50% of the capital costs of the proposed project, thereby reducing the private capital market investment and debt from \$15 million to \$7.5 million. This would have to be justified based on

the related public benefits that would be derived from opportunities such as: Demonstrating a new energy technology application to reduce dependence on fossil fuels; reducing wildfire costs and losses; reducing ecological systems wildfire losses; improving air quality; supporting forest restoration projects; and creating new jobs and tax bases.

- Based on the public benefits of protecting/improving the ecology, reducing the cost and losses from wildfires, and better meeting the long term objectives of improving the air quality in the Grand Canyon region, the various state and federal landowners would have to absorb from \$10 to \$30/BDT, of the costs for disposing of hazardous forest fuels removed as a byproduct of forest restoration projects and offer long-term (preferably ten years) biomass fuel contracts to assure a long term supply of economically available fuel for the proposed project. The delivered costs of the biomass fuels would have to be reduced from \$40/BDT to between \$10 and \$20/BDT for approximately 40,000 BDT needed annually.

8. *Are there alternative approaches that would meet the GFFP objectives of fuel loading reduction and the related public benefits?*

Finding: There are other alternatives that can be considered by GFFP to meet their public benefit objectives:

GFFP could consider being a sponsor of a new demonstration biomass technology that would help commercialize one of the newer (not yet commercially proven) technologies in the market place that could use the hazardous forest fuels as a raw material. There are some promising new biomass utilization technologies that could create new industries using hazardous forest fuels as raw material. Becoming a sponsor of a new biomass demonstration facility could create a new demand for biomass fuels in northern Arizona. If successful, this would have applications for other parts of Arizona with forest fuels problems, and throughout the western states with similar hazardous fuels conditions. GFFP could join other communities in the United States looking for technology that could economically and environmentally create a new local market demand for disposing of biomass fuels. A summary review of new biomass technologies is included in Appendix 1.

- GFFP could work with Arizona Public Service (APS) to evaluate the alternative of co-firing an existing coal plant with biomass fuel from forest restoration projects.
- GFFP could evaluate the cogeneration potential for siting a new biomass power plant adjacent to a user of electrical, steam or process heat. This might include an industrial facility, large commercial facility, or government complex such as a prison or other government installation.

II. BACKGROUND

Forest conditions in northern Arizona are typical of many forested regions in the western United States. As people settled the west, this created the demands and assets to pay for development of wildland fire suppression efforts. More than one hundred years of successful fire suppression efforts have resulted in the unnatural build up of large volumes of vegetation concentrated over millions of acres. This condition of western forests has placed these ecosystems at significant risk of catastrophic forest fires, thus damaging ecological systems, valuable resources, and threatening people and homes. Areas targeted for forest restoration activities that would provide biomass fuels for the proposed project include wildland/urban interface zones near communities, national forests, tribal trust lands, Bureau of Land Management (BLM) managed lands, state lands and private lands.

As these forests are at significant risk, the tourism-based economies of many regions in the west are also at risk. In recent years, recreation based services have replaced the resource management sectors (for example: mining, grazing, and forestry) as the primary revenue generating businesses. These tourism-based economies cannot be adequately sustained if ecosystems that attract visitors to this region are destroyed by catastrophic wildfire.

Arizona, along with many western states, is experiencing increasing wildfire suppression costs and significant adverse impacts to its forest resources, including watersheds and wildlife habitat. Fire suppression costs nationwide are now approaching over \$1 billion for the 2002 fire season. These costs do not include the funds that will be expended for rehabilitation after the fires have been extinguished. Nor do these wildfire suppression costs include the private property losses from homes and other assets lost or damaged by recent wildfires. In addition, wildfire experts warn that we may be faced with more frequent and more severe wildfires for generations to come.

To find a possible solution to help reduce future wildfire costs and losses and provide opportunities for the utilization of biomass generated as a byproduct of forest restoration activities in northern Arizona, the GFFP felt that an assessment for locating a biomass power plant in northern Arizona was warranted. If feasible, the primary goal of a new biomass power plant in northern Arizona would be to create a market demand for biomass fuels removed as a byproduct of forest restoration activities in an attempt to return forested ecosystems to their more historic, natural conditions.

In addition to addressing forest health and hazardous fuels, a secondary goal set by the GFFP for this project, is the development of clean, renewable energy resources for power generation. Electricity and natural gas prices reached unparalleled levels in the west during the winter of 2000 – 2001. These price spikes, coupled with dry winter conditions (reduced hydropower generation output) caused power interruptions and financial hardships for residential and commercial utility customers in several western states. The long-term answer to energy stability is in the development of renewable electrical

generation sources that also provide other public benefits in reducing the costs and losses of wildfires.

III. ARIZONA AND RENEWABLE ENERGY

Arizona is not an electrical energy deficient state, rather it is a net exporter of electricity, with electric wholesale power costs low enough to compete in other western states' electrical markets.

Arizona is primarily dependent on coal, natural gas, nuclear and hydropower electric power plants for its electrical needs. With a growing state population and growing demand for electricity from other western states (such as California and Nevada), Arizona, along with most other western states, is primarily dependent on new natural gas fired power plants to meet long term electrical demand. Natural gas fired plants, with the newer low air emission design and control technologies, are generally more environmentally acceptable than coal fired plants. Natural gas fired plants have become the preferred economical and environmental choice for new electrical generation.

However, an environmental impact issue that will make new natural gas (and coal) fired plants less economical and less environmentally desirable, is the growing worldwide support for the reduction of greenhouse gases (global warming issue). Natural gas fired power plants release significant volumes of carbon dioxide (CO₂) into the atmosphere and thus are not seen as a positive in terms of global warming issues. Generating electricity from renewable energy, such as solar, biomass, landfill gas and wind electric generators, have significant advantages over fossil fuel plants in addressing CO₂ emissions. As a result, in some areas, diversifying a minor percentage of the electrical generation with higher priced renewable energy, yet retaining the advantages of the majority of the electricity coming from low cost natural gas, creates smaller decentralized power plants for improving the electrical grid reliability and produces the renewable public benefits that aren't possible with 100% fossil fuel or nuclear energy generation. This is why Arizona, along with many other states, is attempting to diversify their electricity supply with higher cost renewable energy such as solar, biomass, wind, and landfill gas fired power plants or electrical generating capacity.

Beginning in 1998, Arizona implemented a partial deregulation of its public utilities, allowing customers to contract directly to purchase and wheel power from another generator of electricity, although the distribution, maintenance and billing services will continue to be from the existing utility. The importance of this partial deregulation is that small renewable electrical generating sources could locate near an industrial commercial user, or governmental facility and sell electricity and/or steam at rates above the wholesale grid market. Thus, there are some locations that may provide an opportunity for cogeneration.

As mentioned above, Arizona has implemented an EPS requiring a very small, but expanding percentage of the state's electrical generation be sourced from specific renewable energy sources: predominantly solar, but also wind, landfill gas, and biomass.

The EPS was implemented under the Arizona Corporation Commission Rule R14-2-1618, that requires Electric Service Providers (ESP), including "Load-Serving Entities"

(Utility Distribution Companies) to derive part of their total retail energy, as reflected in the Table III-1. below, from renewable energy sources: solar, wind, landfill gas and biomass. Non-Load –Serving Entities that are ESP's, were given until 2004 to meet the EPS requirements. These other ESP's include rural electric cooperatives and municipal utility districts in the state.

Table III-1. Arizona's Environmental Portfolio Standard Requirement for Electric Service Providers Percent of Total Retail Energy from Renewable Energy Sources	
YEAR	PORTFOLIO PERCENTAGE
2001	0.2
2002	0.4
2003	0.6
2004	0.8
2005	1.0
2006	1.05
2007-2012	1.1

There are a number of subsidies and incentives for solar energy development that dominate the EPS in Arizona. These include mandating that at least 50% of the EPS phase-in technologies are solar electric and no more than 50% can be other renewable technologies. This continues through 2003. From 2004 through 2012, the EPS portfolio kWh makeup shall be at least 60% solar photovoltaic, but no more than 40% solar hot water or other qualified renewables. Extra credit is also given for installations before 2003, with strong preference for solar. There is also an allowance for exceeding the required EPS in previous years, allowing a carryover credit in subsequent years.

The emphasis on solar, a key expanding industry in Arizona, is appropriate in terms of public benefits. However, creating a balanced portfolio, one that includes other renewables such as biomass, will require expanding the EPS where the additional public benefits can justify the expansion. Further improving air quality, supporting forest restoration efforts, and reducing wildfire costs and losses are additional public benefits that new biomass power plants could bring to Arizona.

IV. APPROACH

In the past two decades, TSS has evaluated more than 30 biomass power plants that have been constructed. TSS has conducted feasibility assessments of many other bio-energy projects that were not developed because of fatal flaws in the proposed projects. The bio-energy projects include proposed facilities that would produce electric power, chemical and/or transportation fuel products. TSS has developed a checklist of “Project Viability Issues” that are generic and common to successfully developed bio-energy projects. At this early stage of assessment efforts should concentrate on the evaluation of those key issues that determine the economic viability of a proposed facility. TSS conducted this study using the project viability issues checklist to assess whether a proposed biomass power plant at the Bellemont site would be economical and environmentally viable. These key project viability issues include:

1. *Is there an available long-term supply of biomass that is economically and environmentally viable?*

Biomass utilization facilities are primarily driven by the costs of collecting, processing and transporting the biomass fuel to a proposed facility. For example, for each \$10/BDT of costs for delivered biomass to a power plant, there is a resultant increase of \$0.01/kWh in electrical generation expense. Due to this primary economic driver, the cost of available, delivered fuel is a project viability issue to be assessed carefully at this preliminary feasibility assessment stage.

The second important factor of the available biomass fuel is that it must be sustainable over a long enough period in sufficient quantities that will satisfy equity investors and debt lender’s concerns. Two rules of thumbs are typically used: (1) Can 50 –70% of the biomass fuel be committed under long term contracts that cover the first 5-10 years of the plants operation; and (2) After considering other potential users or competitors of the raw material, is there a multiple of at least 2.5 – 3 times the future volume of fuel available to the proposed plant during the first 10 years of plant operation?

2. *Are there viable electrical power plant technologies available for the proposed 5 MW biomass power plant?*

TSS has recently surveyed the market place for other proposed biomass projects to determine the availability of small electric biomass technologies that would be viable for smaller volumes of forest sourced feedstocks, such as those found in the greater Flagstaff area. There are a number of existing 5 MW and smaller biomass power plants in existence in the United States, Canada and other countries. Many of them have operated for decades, with newer more environmentally benign and more economically efficient technologies also in the marketplace. Having

existing equipment with off the shelf technologies, avoids the financial risks of new unproven commercial technologies.

3. ***Is it probable that the proposed biomass power plant can be permitted at the Bellemont site identified by GFFP and can the proposed plant's environmental impacts can be mitigated to the satisfaction of the regulatory agencies, citizens, communities and other stakeholders?***

An environmental impact evaluation and the likelihood of the project being permit-able is a key project viability issue and is essential to going forward with development expenditures. Issues such as air quality impacts, wastewater discharge, and water usage must be addressed. Community support for the project is also essential for a project to be considered viable.

4. ***Is the proposed biomass plant economically viable and has projected Return on Investment (ROI) that will attract equity and debt financing?***

The private financial sector is motivated to make investments if the risks can be identified and mitigated and an adequate return can be made on its investments in facilities such as new biomass power plants. For off the shelf technologies to be used in developing a new biomass power plant in today's financial and investor markets, the ROI of 14% to 20% are required; for newer unproven and higher risk technologies, ROI's of 17% to 25% are needed to attract the necessary equity investors and debt lenders.

5. ***Does the current electrical market offer viable rates and revenue to justify the capital investment?***

All businesses are primarily driven by revenues. For a proposed biomass power plant to be viable, it must have potential market revenues to cover its capital investment costs, operating and reserve costs, periodic maintenance, pay its debt and return a profit on equity investments. TSS has developed customized preliminary financial models (refer to section X. Preliminary Financial Projections) that show the required power purchase agreement rates needed under various scenarios.

6. ***Is the proposed biomass power project sufficiently viable to attract a developer, development team, and credible operating staff that will satisfy the financial markets?***

Incorporating the assessment of the first five project viability issues referenced above, TSS examined the likelihood that this project would attract the next primary ingredient for a new facility to be developed, financed and operated.

7. *What would be needed in the market place to support a new biomass power plant in northern Arizona?*

TSS added this project viability issue after it was determined that the combination of the existing wholesale electrical energy markets and the existing public markets for creating new public benefits in the renewable energy, jobs creation, forest health improvement and wildfire impact mitigation would not yet support development of a new biomass power plant in northern Arizona. TSS also identified what would have to happen in the market place for the potential biomass power plant to be built and operated, if the public and private decision makers determine that the public and private benefits warrant the needed investments.

8. *Are there alternative approaches for addressing this project that would meet the GFFP objectives of forest restoration and the related public benefits?*

An appropriate question in this type of analysis is whether the objectives of the GFFP in supporting forest restoration could be met by sponsoring a newer biomass demonstration technology application using the biomass fuels generated from the greater Flagstaff area. Emerging biomass utilization technologies that are attempting to demonstrate viable commercial applications are higher risk projects. However, such applications are often driven by the public benefits to attract cost sharing grants and risk capital from private investors who would benefit from owning the rights to a newly commercialized technology. This requires attracting public and private partnerships to share the risk, costs, and benefits from joint venturing these kinds of projects. Section XII. of this report was added by TSS to identify other alternatives to address the GFFP objectives.

V. PROJECT DESCRIPTION

Three basic guidelines were given to TSS by GFFP for this analysis:

- (1) Because water is such a valuable commodity, and a relatively scarce resource, in northern Arizona, a proposed biomass power plant would have to minimize water consumption so as to not significantly impact the local aquifer;
- (2) GFFP conducted its own alternative site search and evaluation and confirmed the Bellemont site as the target study site for TSS to conduct this assessment of a proposed biomass power plant;
- (3) At least one financial projection must include a scenario that assumes no federal or state incentives available as subsidies or electric power price supports (see base case scenario in Section X. – Preliminary Financial Projections).

As reflected in the biomass fuel assessment later in this report (see Section VII. – Biomass Fuel Assessment) the availability of the biomass fuel is the key limiting criteria in sizing a potential new biomass power plant. For new biomass facilities, a rule of thumb used by the financial markets in risk assessment is that the available fuel, and tributary fuel should be in a minimum range of two and one half to three times the long term annual fuel demand for a plant. Given the available fuel, after taking into account current and potential competitive demand for the raw material, TSS concluded that a 5 MW gross output or 4.5 MW net output to the grid plant would be the maximum that the available fuel in the Bellemont area could supply on a long-term basis. Using this figure the following project parameters were developed as the project description assumptions. These assumptions are critical in making preliminary financial projections, capital investments and operating costs and preliminary environmental impacts analyses to determine whether a new plant is likely to be permitted and accepted by the citizens, communities, regulatory agencies, and other stakeholders.

Plant Description assumptions are as follows:

Plant Size:	4.5 MW, net; 5.0 MW, gross
Operations:	329 days per year
Fuel:	Forest residue and slash: 100% biomass fuel
Fuel cost:	\$40/bone dry ton (BDT)
Tonnage Required:	40,000 BDT per year
On Site Fuel Storage:	4 months
Acreage:	20 acres
High Heating Value:	8,500 British thermal unit (BTU)/pound
Ash Content:	3%
Ash Disposal:	Soil amendment; cost \$10/ton for trucking
Zoning:	Industrial
Interconnection:	Arizona Public Service
Project Schedule:	6 months to permit; 12 months to construct.
Construction Jobs:	100 at peak
Operations Jobs:	15
Water Usage:	1-10 gallon per minute; 1.2-11 acre-feet per year

VI. SITE SELECTION

The siting location of a new power generation facility is crucial to its long-term economic viability. In the consideration of a biomass fired power plant, this is even more the case due to the economic relationship between haul distance from potential fuel sources and delivered cost of the fuel.

Site selection was not part of the TSS assignment in this assessment. GFFP conducted their own site evaluation, requesting some assistance from TSS in identifying the criteria that would have been used had TSS conducted a site alternatives evaluation. As part of the pre-site selection process, a list of preliminary site analysis questions were developed by TSS for GFFP staff to use in reviewing potential project sites (see Appendix 2. – Preliminary Assessment Questions). Four northern Arizona sites were considered:

- Ecolena Business Park – Winslow
- Camp Navajo - Bellemont
- Cholla Power Plant (Arizona Public Service) – Joseph City
- Bellemont Industrial Park – Bellemont

Of the candidate sites, the industrial park at Bellemont was chosen by GFFP as the target study site. This siting decision was based upon a number of factors, but primarily:

- Proximity of potential biomass fuel supply
- Transportation infrastructure – highway and rail
- Proximity to transmission and distribution systems
- Existing land uses and zoning
- Availability of natural gas (for plant start up)
- Potential for co-location of process steam or heat customer
- Probable acceptance by local communities and concerned stakeholders

Once the target study site was chosen, GFFP requested that TSS also examine the possibility of cogeneration versus electrical generation only for sale of power to the grid. Cogeneration has an advantage over generation for sale to the grid, in that it provides higher returns to the generator, yet lower costs to the co-located user; is not dependent on transmission lines (no wheeling costs) and; offers opportunities for other revenue streams such as the sale of steam, heat and/or electricity to co-located customers. The sale of steam, heat and electricity allows for more economical and efficient power plant operation as well as additional and often higher revenue over selling only to the grid at

wholesale prices. Several potential electrical and steam customers in the Bellemont area were contacted including:

- Camp Navajo
- SCA Tissue
- Forest Energy Corporation

At this time the delivered energy costs to these potential purchasers of steam and/or electricity is significantly below the generation cost of electricity and steam that a 5 MW biomass might produce. However, the current cogeneration power sales market in northern Arizona is in the \$0.06+/kWh range. As noted in the executive summary, the wholesale power rate that a new electrical generator might be able to sell electricity to a power utility is in the \$0.03/kWh range. The sale of power and steam from a biomass plant operating as a cogeneration facility does have a power/energy sales advantage over the sale of power into the wholesale power market.

VII. BIOMASS FUEL ASSESSMENT

The biomass fuels assessment portion of this preliminary feasibility assessment seeks to determine the potential biomass fuels resources reasonably available (economically and environmentally sustainable) for the project located at Bellemont. This assessment reviewed the availability and cost of biomass fuel from:

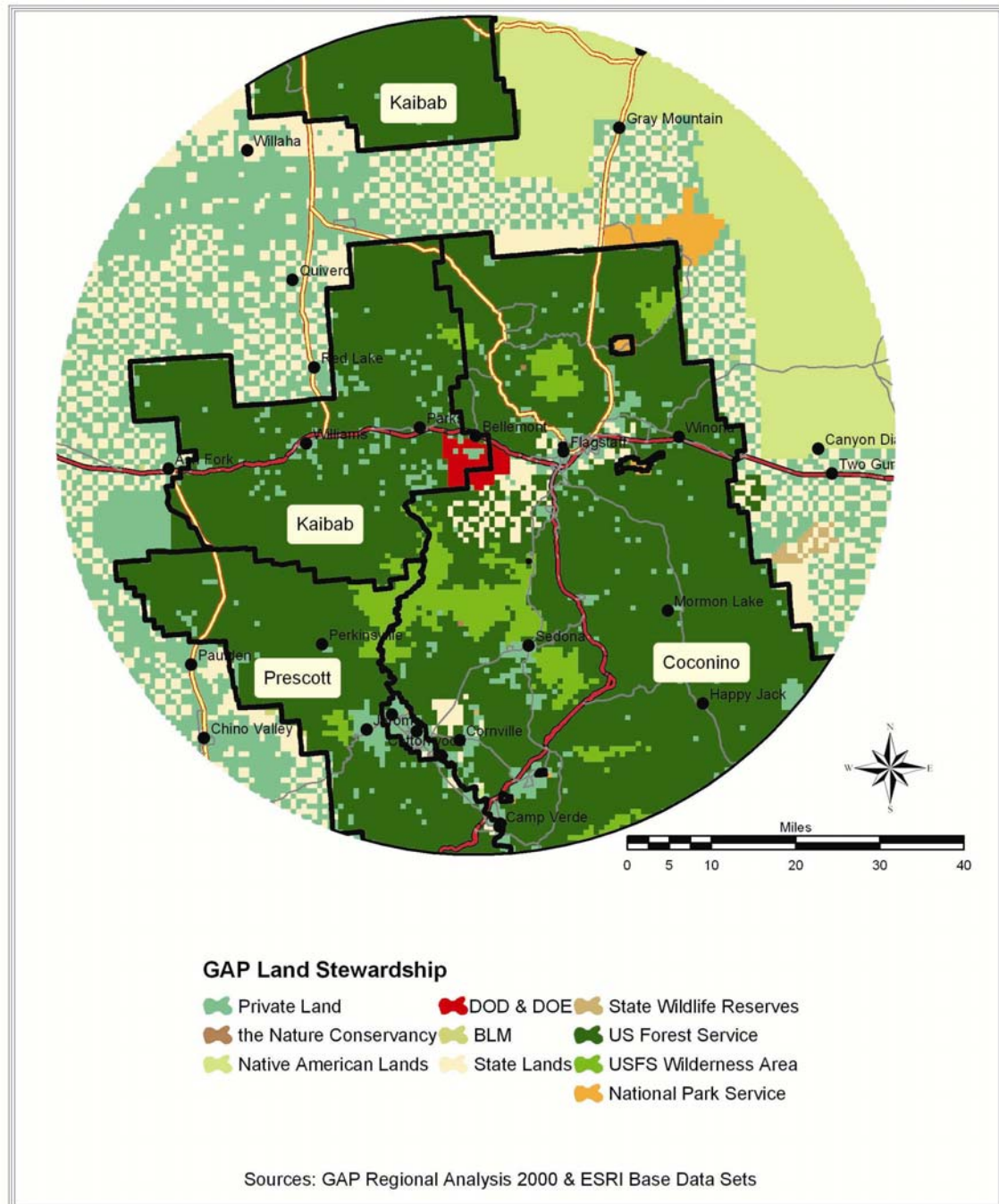
- Timber harvest operations
- Forest restoration operations
- Pinyon-Juniper removal/range + watershed improvement activities
- Forest product manufacturing facilities (sawmills)

For the purpose of this assessment the Bellemont market area is considered to be that geographic region included within a 50-mile radius of Bellemont (see Map 1).

Forest Residue Availability

The biomass fuel assessment relied primarily upon data received from the United States Department of Agriculture's Forest Service for the National Forests within a 75 – mile radius of the Bellemont project site. This data reflected the planned timber harvest and timber stand improvement (TSI) thinning (forest restoration) for fuel reduction and growth. The planning period covered the years 2002 – 2006. This data was adjusted to include only the planned activity within a 50 - mile radius of the Bellemont project site. Map 1 shows the ownership of lands within 50 miles of the Bellemont project site.

MAP 1: Ownership of Lands Within 50 Miles of Bellemont, AZ



Forest Residue from Timber Harvesting

Table VII-1. contains information summarizing planned timber harvesting activities in the three National Forests located within a 50-mile radius of the Bellemont site. Forest residues generated as a byproduct of harvesting activities can vary significantly due to saw timber utilization standards for end products such as lumber and veneer. Based upon TSS experience with timber harvest activities in ponderosa pine and mixed conifer type forests of the west, TSS estimates that approximately 0.9 bone dry ton (BDT) of forest residue could be generated for each thousand board feet (MBF) of timber harvested.

Table VII-1. Potential Forest Residue Generated From Planned National Forest Timber Harvest					
Forest	2002	2003	2004	2005	2006
Coconino Planned Harvest	25,829 MBF	36,931 MBF	36,399 MBF	35,465 MBF	35,041 MBF
Est. BDT/MBF	0.9	0.9	0.9	0.9	0.9
Total BDT	23,246	33,238	32,759	31,918	31,537
Kaibab Planned Harvest	21,155 MBF	15,920 MBF	13,216 MBF	11,750 MBF	16,163 MBF
BDT/MBF	0.9	0.9	0.9	0.9	0.9
Total BDT	19,040	14,328	11,894	10,575	14,547
Prescott Planned Harvest	941 MBF	2,426 MBF	2,829 MBF	2,058 MBF	2,058 MBF
BDT/MBF	0.9	0.9	0.9	0.9	0.9
Total BDT	847	2,183	2,546	1,852	1,852
Total Available all National Forests	43,133	49,749	47,200	44,345	47,936

The average potential biomass fuel generated from timber harvest activities on National Forests in the Bellemont market area is 46,472 BDT per year for the next five year period.

Table VII-2. is the TSS estimate of the potential forest residue generated from timber harvest activities on private timberland in the Bellemont market area. TSS has assumed that the privately owned acreage of ponderosa pine and mixed conifer could sustain some level of harvest over the next 20 years. TSS estimates that an average of 12 BDT per acre of biomass fuel could be collected along with and complimentary to these projected timber harvest levels.

Table VII-2. Potential Forest Residue Generated From Private Timber Harvest					
Private	2002	2003	2004	2005	2006
Est. Private Harvest Acres/Year	2,499	2,499	2,499	2,499	2,499
Est. BDT/Acre	12	12	12	12	12
Total BDT	29,993	29,993	29,993	29,993	29,993

Table VII-3. reflects the TSS estimate of the potential forest residue generated from timber harvest activities on State Trust timberland. TSS has assumed that the acreage of ponderosa pine and mixed conifer could sustain some level of harvest over the next 20 years. TSS estimates that an average of 12 BDT per acre of biomass fuel could be collected along with and complimentary to these projected timber harvest levels.

Table VII-3. Potential Forest Residue Generated From State Trust Timber Harvest					
Private	2002	2003	2004	2005	2006
Est. Private Harvest Acres/Year	1,485	1,485	1,485	1,485	1,485
Est. BDT/Acre	12	12	12	12	12
Total BDT	17,821	17,821	17,821	17,821	17,821

Forest Residue From Restoration Activities

TSS has reviewed the current forest conditions at the Camp Navajo military installation and estimates that forest restoration activities (primarily thinning) could occur on the entire forest over the next 20 years, generating an average of 12 BDT per acre, or an average of 15,221 BDT per year (see Table VII-4.).

Table VII-4. Potential Forest Residue Generated From Camp Navajo Forest Restoration Activities					
	2002	2003	2004	2005	2006
Est. Thinning Acres/Year	1,268	1,268	1,268	1,268	1,268
Est. BDT/Acre	12	12	12	12	12
Total BDT	15,221	15,221	15,221	15,221	15,221

Along with the GFFP, TSS believes that there is strong localized interest in conducting forest health improvement/forest restoration activities if a biomass fuels market existed. In order for fuels treatment to be conducted and deliver fuel to a power plant, all costs for collection, processing and transportation need to be addressed. If the fuel market values do not support all of the costs, it is unlikely that biomass fuel would be available from private lands.

The ponderosa pine and mixed conifer vegetation in private ownership within the Bellemont market area amounts to approximately 49,988 acres. TSS has estimated that all of this acreage could be thinned (forest restoration activities) over a 20 year period, or approximately 2,499 acres per year. Approximately 12 BDT per acre would be recovered as a byproduct as biomass fuel.

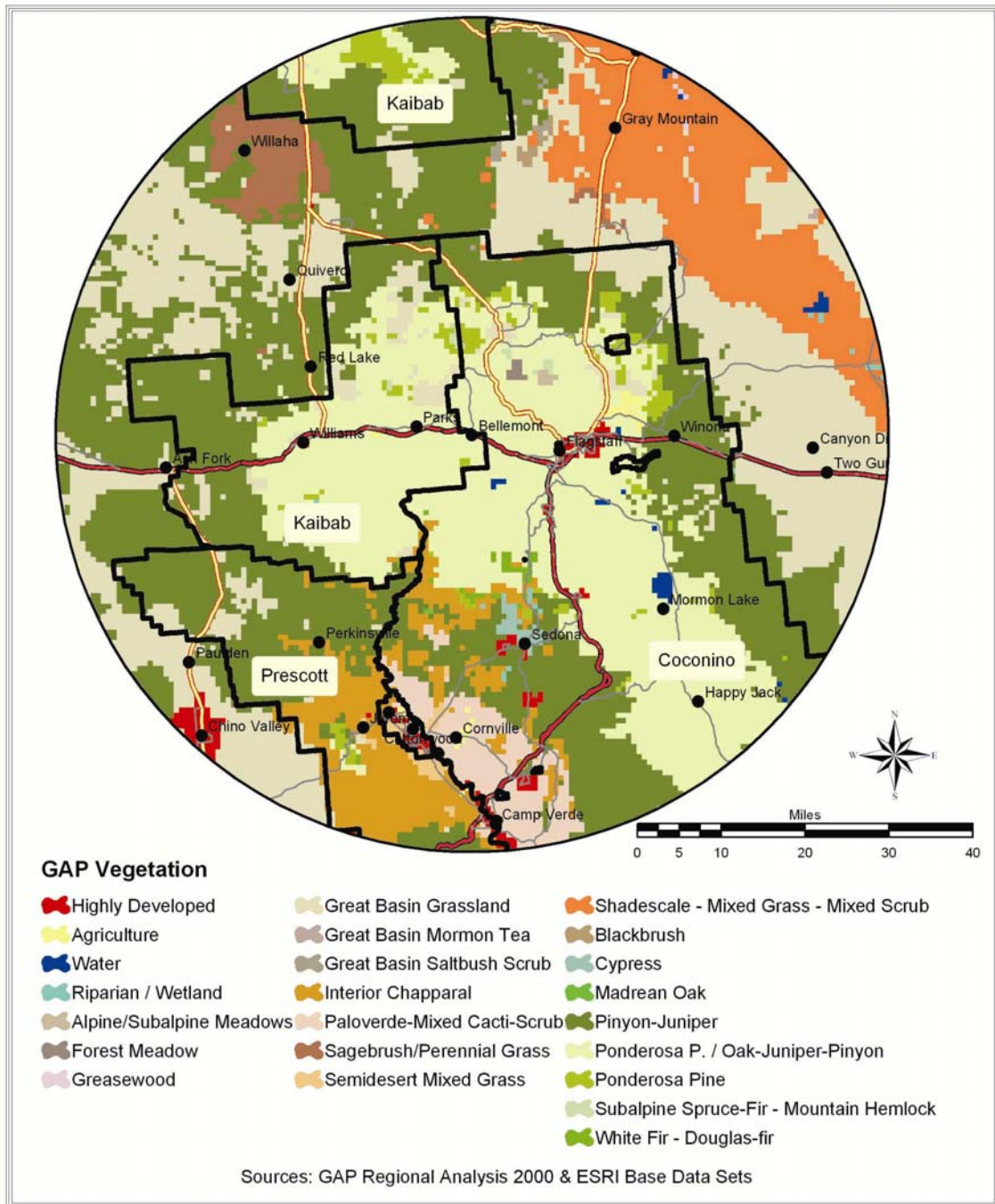
Forest Residue from National Forest – Forest Restoration

Table VII-5. presents the forest restoration (timber stand improvement thinning) plans for the three National Forests within a 50 – mile radius of the Bellemont project site. Based upon a review of forestlands in this area, TSS estimated that an average of 8 BDT per acre of biomass fuel could be recovered as a byproduct of forest restoration. Based upon these assumptions, an average of 18,981 BDT would be generated per year for the next five years.

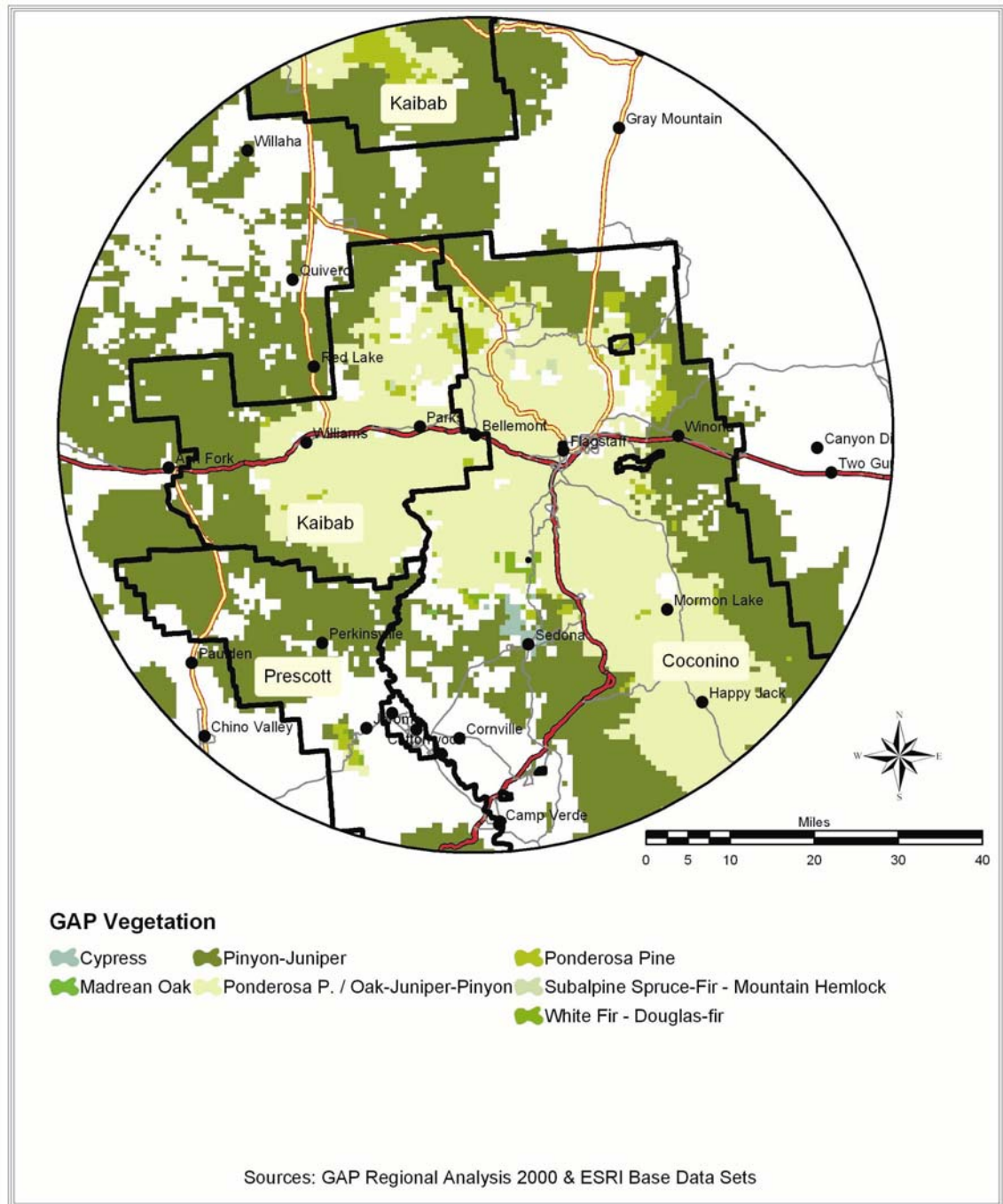
Table VII-5. Potential Forest Residue Generated From Planned National Forest Restoration Activities					
Forest	2002	2003	2004	2005	2006
Coconino Planned TSI Acres	625	2,352	1,911	2,205	1,838
BDT/Acre	8	8	8	8	8
Total BDT	5,000	18,816	15,288	17,640	14,704
Kaibab Planned TSI Acres	1,125	1,250	147	0	0
BDT/Acre	8	8	8	8	8
Total BDT	9,000	10,000	1,176	0	0
Prescott Planned TSI Acres	82	82	82	82	82
BDT/Acre	8	8	8	8	8
Total BDT	656	656	656	656	656
Total Available All National Forests	14,656	29,472	17,120	18,296	15,360

The following Maps - Map 2: GAP Vegetation Within 50 Miles of Bellemont, AZ and Map 3: Target Forest Types Within 50 miles of Bellemont, AZ illustrate the major vegetation types. Fuel volumes available on a sustained basis over time are directly dependent upon vegetation type. Vegetation and land ownership data was available from the Geographic Analysis Program (GAP) regional analysis. Environmental Science Research Institute (ESRI) data sets were utilized to accurately place the roads and cities on the maps.

MAP 2: GAP Vegetation Within 50 Miles of Bellemont, AZ



MAP 3: Target Forest Types Within 50 Miles of Belmont, AZ



Forest Residue from Pinyon-Juniper Harvest on Public and Private Lands

Tables VII-6. and VII-7. present the TSS estimate of the potential biomass fuel that could be generated from pinyon-juniper harvest on public and private lands to address wildlife habitat needs, range and watershed improvement/restoration. TSS presumed that the pinyon-juniper stands with a density over 40% crown closure would be targets for some level of removal to reduce crown closure and stem density in support of fuels reduction, range improvement and watershed improvement. Much of the land that supports the pinyon-juniper type is difficult to treat with mechanical harvesting equipment. It is estimated that 25% of the acreage could be treated, and that these acres would be treated over a 30 year period. Based upon discussions with logging contractors now operating in pinyon-juniper vegetation type, TSS estimated that an average of 8 BDT of biomass fuel could be generated per acre.

Table VII-6. Potential Biomass Fuel Generated From Pinyon-Juniper Harvest on Public Lands					
Ownership	Total Acres	Canopy Density over 40%	Acres to Treat/Year	BDT/Acre	BDT/Year
Coconino NF	503,242	14	528	8	4,227
Kaibab NF	374,856	46	1,293	8	10,346
Prescott NF	200,697	16	241	8	1,927
State Trust	240,074	14	252	8	2,017
Total Public Acres	1,318,869		2,314		18,517

Table VII-7. Potential Biomass Fuel Generated From Pinyon-Juniper Harvest non-USFS Lands					
Ownership	Total Acres	Canopy Density over 40%	Acres to Treat/Year	BDT/Acre	BDT/Year
Private	362,504	14	414	8	3,313
Navajo Indian Reservation	46,428	14	49	8	390
Total Acres	440,917		463		3,703

Sawmill Residuals Availability

Typically sawmill residuals, including bark, sawdust, chips and shavings are generated as a byproduct of the log and lumber manufacturing process. These residuals, depending upon local market demands, may be available as an economical fuel source for a biomass power plant. Most sawmills operate on a twelve-month per year basis, and as such tend to generate residuals consistently year round.

Commercial sawmills now operating in northern Arizona are summarized in Table VII-8. below:

Table VII-8. Regional Sawmill -- Residuals Availability				
Facility	Location	Distance from Belmont	Haul Cost (\$/BDT)	Comments
Precision Pine	Heber, AZ	146 miles	\$24.71	
Southwest Forest Products	Phoenix, AZ	152 miles	\$25.72	All residuals committed to soil amendment markets.
White Mountain Apache Tribe	Cibecue, AZ	192 miles	\$32.49	
White Mountain Apache Tribe	White River, AZ	198 miles	\$33.51	
Precision Pine/San Carlos Apache Tribe	Globe, AZ	240 miles	\$40.62	Currently down. May operate under lease between PP and San Carlos Apache Tribe

For more detail – refer to Appendix 3. Northern Arizona Forest Products Operations - Summary Of Fiber By-Products Produced

There are no sawmills operating within the Belmont area. The closest sawmill is Precision Pine at Heber, located 146 miles from the project site. This sawmill is currently operating on a one shift, eight-hour per day basis. The operation has been restricted in the scheduling of additional shifts due to limited and inconsistent saw log availability. As fire salvage operations are conducted in the Rodeo-Chediski fire clean up efforts, more saw logs may become available and this operation could operate on a two-shift basis.

A review of Precision Pine's current residual production and markets are summarized below in Table VII-9:

Table VII-9. Precision Pine's Biomass Residual Production and Markets		
Residual	Current Production/day	Current Markets
Chips	24 BDT (48 green tons at 50%moisture content)	Mulch – Phoenix Wood pellets – Show Low
Sawdust	10 BDT (20 green tons at 50% moisture content)	Horse bedding – Phoenix and Prescott
Bark	9 BDT (14 green tons at 35% moisture content)	Decorative bark - Phoenix
Shavings	7.5 BDT (9 green tons at 15 % moisture content)	Wood pellets processed on site at Heber. Occasionally sell to animal bedding market

Precision Pine management staff noted a willingness to consider marketing chips to a power plant at Bellemont if the market value was competitive with the mulch and wood pellet markets. All of the other residuals – sawdust, bark and shavings are being marketed successfully to relatively high value markets.

It would appear that the chip volume generated at Precision Pine could be available on a multiple year basis if valued competitively. The Heber operation processes predominantly ponderosa pine saw logs and so, generates ponderosa pine chips that have a relatively good heating value when compared to other biomass fuels. The higher heating value (HHV) of ponderosa pine chips is approximately 9,100 British thermal units (BTU)/oven-dry pound. This compares favorably with other softwood species – for example:

- True fir chips – 8,300 BTU/oven-dry pound
- Douglas fir chips – 8,900 BTU/oven-dry pound

The major expense to deliver residuals from Heber to Bellemont would be the cost of transportation. Hauling contractors in the northern Arizona region were interviewed regarding transport rates. Haul rates for the transport of sawmill residuals in conventional trucks range from \$1.05 to \$1.20 per road mile and haul an average of 26 green tons (net weight). A haul rate of \$1.10 per mile was used in this assessment. Assuming that a commercial truck can transport 26 green tons and the chips have a moisture content of 50% (one half water and one half fiber) then approximately 13 bone dry tons (BDT) can be hauled. Using a \$1.10 per mile haul rate then the cost to transport chips approximately 146 miles (292 mile round trip distance) from Heber to Bellemont will be approximately \$25/BDT.

Due to transportation costs and the concern for long-term availability (alternative markets closer to Heber) the sawmill residuals from the Precision Pine operation were not

considered as available to a power plant located at Bellemont on a sustainable and economic basis.

Sawmill Residuals Availability – Potential Operations

As public interest in restoration/rehabilitation of western forests in the United States has continued to build, so too has the interest in how best to utilize material (small trees) that may be removed in the process of restoring forest health. There is considerable interest on the part of some northern Arizona based entrepreneurs in the development of sawmill facilities that would utilize small logs.

In July 2002 Mater Engineering issued an executive summary titled *“Wrap-up and Implementation Report, Restoration Resources and Investment Potential”* to the GFFP. The report summary indicated the following:

“Using forest stewardship and restoration activities as a base in 2001, the region (northern Arizona) began harvesting sufficient volumes of wood resource to warrant serious consideration of establishing an efficient small log processing operation”

Mater Engineering staff noted that three sites are being considered for further study as potential small log processing sites as summarized in Table VII-10:

Table VII-10. Potential Small Log Processing Sites Mater Engineering Report, July 2002	
Location	Distance from Bellemont
Williams, AZ	23 miles
Winslow, AZ	70 miles
Eagar, AZ	195 miles

Should an operation be located at either the Williams or Winslow sites, sawmill residuals could be available and transported economically to Bellemont.

Competition for Wood Fiber

Currently, markets for wood fiber in northern Arizona are limited to soil amendment, animal bedding, decorative bark and feedstock for pelletized fuel (wood pellets for residential heating use). Summarized below in Table VII-11. are the markets and their locations:

Table VII-11. Northern Arizona Markets for Wood Fiber		
Fiber	Current Markets	Location
Chips	Mulch/compost	Phoenix/Tucson
Chips	Wood pellets	Show Low
Sawdust	Animal bedding	Phoenix/Prescott/Tucson
Bark	Decorative bark	Phoenix/Tucson
Shaving	Animal bedding	Phoenix/Prescott/Tucson

Currently, all of these end uses for wood fiber represent finite markets that are serviced by existing Arizona suppliers – mostly sawmills. Any wood fiber generated during forest restoration activities may be diverted to some of these markets – but only those that are located within an economical haul distance of the market. The Bellemont region is located some distance from these markets and as such should not be impacted by these competing markets for wood fiber.

Urban Wood Availability

In recent years communities have begun separating wood waste in an effort to minimize waste material being deposited in landfills. This not only extends the life of the landfills, but facilitates more complete utilization of a waste product. Much of the wood waste that is segregated at the landfills and transfer stations consists of tree trimmings, demolition wood, pallets, and brush. This waste, if segregated and processed appropriately, can be utilized as biomass fuel. While assessment of urban wood was not included in the scope of work for this project, consideration should be made to assess the availability of this potential biomass fuel resource, if the next phase of the project proceeds.

Cost of Biomass Fuel – Collection, Processing and Transport

To better understand the cost of biomass fuel delivered to a power generation facility, the full costs of collection must be assessed. Limited biomass fuel recovery activities have occurred in the Flagstaff area due to a lack of market demand for biomass fuels. The majority of forest restoration for fuels reduction has been done by hand and the residue has been piled and made available for firewood or burned in place for disposal.

Based upon interviews conducted with northern Arizona logging contractors and TSS staff experience in treating forest fuels, TSS has estimated the costs of collection, processing and transportation for this project.

Table VII-12. reflects the expected cost of to collect, process and transport biomass fuel from the major sources. The findings are presented in a low and high range due to the number of variables that can affect costs of operation including:

- Haul distance to facility
- Vegetation type and density
- Cost of diesel fuel
- Cost of labor
- Haul road improvement and maintenance

Table VII-12. Cost of Biomass Fuel Collection, Processing And Transportation			
Source	Activity	Low Estimate \$/BDT	High Estimate \$/BDT
Forest Residues – Timber Harvest	Shearing (fall and place stems in bundles)	\$5	\$10
	Skidding	\$5	\$7
	Chipping	\$10	\$12
	Transportation	\$9	\$15
	<i>Subtotal</i>	\$29	\$44
Fuels Treatment/Forest Restoration	Shearing	\$10	\$13
	Skidding	\$7	\$11
	Chipping	\$9	\$12
	Transportation	\$9	\$15
	<i>Subtotal</i>	\$35	\$51
Pinyon-Juniper Removal	Shearing	\$12	\$14
	Skidding	\$8	\$12
	Chipping	\$10	\$13
	Transportation	\$10	\$17
	<i>Subtotal</i>	\$40	\$56

Fuel Cost Summary

In order to complete financial projections for the operation of a biomass power plant, an estimate of the annual fuel procurement mix must be made. For the purposes of this assessment, a biomass fuel procurement projection was made using the average of the low/high costs and was based on the following biomass fuel blend:

Table VII-13. Annual Fuel Mix And Cost Projection		
Fuel Type	BDT	\$/BDT
Forest Residues – Timber Harvest	23,000	\$36.50
Fuels Treatment/Forest Thinning	10,500	\$43.00
Pinyon-Juniper Removal	6,500	\$48.00
Totals	40,000	\$40.07

Findings

TSS assessed the availability of biomass fuel resources within the Bellemont market area and finds that approximately 150,708 BDT of biomass fuel is potentially available on an annual basis. This volume of biomass fuel is sufficient to support a 5 MW power plant, assuming a 2.5x to 3.0x fuel supply coverage ratio.

Estimated delivered cost for the fuel is approximately \$40/BDT.

Table VII-14. Summary of Biomass Fuel Potentially Available on an Annual Basis	
Fuel Type	Bone Dry Tons
Forest Residues – Timber Harvest	94,286
Fuels Treatment/Forest Thinning	34,202
Pinyon-Juniper Removal	22,220
Total	150,708

VIII. PRELIMINARY ENVIRONMENTAL ASSESSMENT

Introduction and Site Description

The Bellemont site is located approximately 12 miles west of Flagstaff, directly south of Interstate 40. It is a vacant, grassland/sagebrush area adjacent to ponderosa pine forestlands. It is a slightly easterly sloping site and is relatively flat (see photo below).

To the south of the site is Camp Navajo, a former Army base that is now principally occupied by the Arizona National Guard. This defense facility is also a large munitions storage facility. Between the site and Camp Navajo are the Burlington Northern/Santa Fe Railroad tracks. These railroad tracks are a major east-west route. Up to 100 trains pass through this area every day. On the northern edge of the site is Old Highway 66, with Interstate 40, a major east-west vehicular route, just farther to the north (approximately 500 feet). To the east of the site is a large tissue paper manufacturing facility (SCA Tissue). As referenced above, to the west are ponderosa pine forestlands, the dominant landscape feature for this portion of Arizona.



**Potential Biomass Power Plant Site in Bellemont, AZ
(View looking south from north side of site)**

General Power Plant Features

A proposed power plant would consist of biomass-fired boilers utilizing forest residues, producing steam to run electrical generation equipment. Dry cooling towers will be utilized to minimize water needs, as well as wastewater discharge. For air emissions, the plant will be designed with Best Available Control Technology (BACT) for emissions such as oxides of nitrogen (NO_x), oxides of sulfur (SO_x), and particulate matter (PM). BACT implies the most stringent emission control technique that has been achieved in practice and is commercially available.

Principal Regulatory Agency Involvement

The principal regulatory agencies that would be involved with the project include:

- Arizona Dept. of Environmental Quality, Air Quality Division (air emissions)
- Arizona Dept. of Environmental Quality, Water Quality Division (wastewater)
- Coconino County Department of Community Development (land use)

Land Use and Zoning

The Coconino County Community Development Department has designated the general Bellemont area as a Planned Community (PC) Zone. As per the most recent zoning map, the proposed project site is zoned M-1-10,000 Light Industrial. Per Section 12.0 of the Coconino County Zoning Ordinance, this zone is “intended for light industrial and limited service commercial uses that can meet high performance standards but that frequently do not meet site development standards appropriate to planned research and development of industrial parks”. However, this zone does allow, per Section 12.1, electrical generating stations and substations provided such facility apply for and receive a Condition Use Permit (CUP) from Coconino County. Discussions with Coconino County Community Development staff confirm that a biomass power plant could be constructed and operated on the site provided the proposed facility obtains a CUP.¹

In order to obtain a CUP, in addition to a relatively standard application submittal, Section 19.2 of the Coconino County Zoning Ordinance requires that a citizen participation plan be prepared, and implemented. Tenets of this plan require that the CUP applicant contact neighbors and other potentially affected property owners in the proposed project vicinity and inform them about the project and solicit their input regarding the project. Prior to the submittal of the CUP application, prospective applicants must conduct a neighborhood community meeting. The scope and breadth of

¹ John Aber, Coconino County Community Development Department, April 29, 2002 meeting

the citizen participation plan is determined by the applicant, but after consultation with the Coconino County Community Development.

Community Development staff also expressed some concerns regarding the subdivision process for the proposed site. The site is part of a larger parcel that will need to go through the Coconino County subdivision process. This process can occur concurrent with the CUP process. A subdivision application will need to be submitted to the Community Development Department.

Another land use related concern raised by the Community Development staff was adherence by the proposed project to County Zoning Ordinance Section 17, and specifically Section 17.4 – Establishment of Astronomical Zones. Due to various astronomical telescopes located in Coconino County, there are three distinct zones in the county, which dictate the use of lighting at a facility. The proposed power plant is in the least restrictive zone and lighting at the facility should not be problematic.

Air Quality Standards

Air quality in Coconino County can be considered good. In regards to exceeding federal or state air quality standards, Coconino County had no exceedances for ozone, carbon monoxide, PM10 (particulate matter 10 microns or less in size) or ozone in 1998, 1999, or 2001.² According to Arizona Department of Environmental Quality (ADEQ), Air Quality Division maps, the project area is in attainment of federal and state air quality standards for ozone, PM10, SOx, and carbon monoxide (CO). The closest non-attainment area is a relatively small area of PM10 non-attainment centered around Payson, Arizona, approximately 75 miles to the south-southeast of the Bellemont area.

Visibility, as an air quality issue, is of paramount concern in northern Arizona, principally to the scenic amenities of the region. There are several areas in the region designated by the U.S. Environmental Protection Agency (USEPA) as Class I visibility areas. Such an area is provided extra protection by the USEPA in regards to visibility and scenic view shed impairment. The proposed project is located approximately 12 miles from the nearest Class I area. This will require that during the air quality permitting activities additional modeling and evaluation will be necessary to determine if there will be any impact to the Class I visibility area.

The proposed biomass power plant will be designed with BACT for NOx, SOx, and PM. The NOx emission control system will be an ammonia injection system, with limestone injection for any necessary SOx control. PM would be controlled via a bag-house or electro-static precipitator (ESP). Carbon monoxide and volatile organic compounds (VOC) emissions will most likely be controlled via standard combustion controls.

Using data from a similar facility, estimated controlled emissions for the biomass power plant could be – NOx, 84 tons/year; SOx, 4.2 tons/year; PM, 40 tons/year; CO, 20

² 2001 Arizona Department of Environmental Quality Annual Report

tons/year; VOCs; 1 ton/year. It is estimated that the energy input for the biomass power plant will be approximately 66 million Btu per hour (annual energy input divided by operating hours).

Based on these emissions and energy input, an air quality permit is required by the ADEQ Air Quality Division for this project. However, based on the estimated emissions for the plant, it does not appear that the permit facility would be classified as a Class I permit. In order to qualify for a Class I permit, the facility would have to have the potential to emit 100 tons per year (or more) of one of the air pollutants above. This level of pollutants would also designate a facility as a “major stationary source”. Since none of the pollutants exceed 100 tons per year, a Class II permit can be sought for the facility. This will lessen the permitting activities and time to acquire a permit; probably to less than six months from the date a complete air quality permit application is submitted to the ADEQ Air Quality Division.

Wastewater Standards

To reduce water consumption the proposed power plant will utilize an air-cooled condenser. Potential wastewater discharge from an air-cooled 5 MW plant is estimated to be in the 2-4 gallons per minute (gpm) range. If this amount is not reduced prior to discharge this would result in 5,760 gallons per day, or 173,000 gallons per month which would have to be discharged to a lined impoundment and subjected to ambient vapor-transpiration for ultimate disposal (i.e. evaporation). This impoundment would need to be very large to handle full wastewater discharge. In addition, evapo-transpiration would be very limited in the winter thus requiring several acres of lined impoundments. A percolation pond would most likely not be permit-able due to shallow, and heavily used, groundwater aquifer. In addition, percolation rates are extremely slow in the Bellemont area. Thus, in designing the wastewater handling system, a “zero-discharge” approach might be necessary. Such an approach could utilize a reverse osmosis system or a power evaporation unit to minimize wastewater limit as much as possible. Both systems would increase the “parasitic” load on the power plant electrical output.

If lined impoundments are to be used for the project, a water quality permit will have to be obtained from the ADEQ Water Quality Division. Fortunately, the Division has instituted a general permitting program, which makes such permitting relatively streamlined.

The proposed project will also require a storm water discharge permit from the ADEQ Water Quality Division.

Plant Siting/Configuration

The proposed biomass power plant “foot print”, which accommodates the boiler, electric generating equipment, dry-cooling towers, and other ancillary power plant equipment and structures, will be approximately two acres. A fuel storage and handling area will need

approximately 10 acres. Depending on the design of the wastewater handling system, several additional acres of lined impoundments might also be necessary.

Transportation and Infrastructure

Interstate 40, a major east-west transportation route, serves the proposed site. There is adequate access, with the need for some improvements, to the proposed power plant for biomass fuel carrying trucks. It was observed that numerous trucks are currently accessing the SCA Tissue industrial plant located adjacent to the proposed facility site. If necessary, there is also adequate access for the installation of a rail siding.

It is projected that no more than an average of two trucks per hour during business hours would need to access the proposed site. Assuming a 9 month delivery window (winter weather and snow preclude year round deliveries) and each truck averaging 13 BDT per delivery, this would mean an average of approximately 17 delivery trucks per day on a Monday through Friday schedule.

Water Availability

It is proposed that the power plant be air-cooled to limit water use. Water use for 5 MW would be approximately 8 to 10 gpm. This compares very favorably with wet-cooling system, which would use 100+ gpm. This lower usage is extremely important in the Bellemont area, as water availability is very low. In addition, the current extreme drought that northern Arizona is experiencing has further reduced water availability. The Bellemont Water Company reports that their available water for sale from local wells was less than 1 million gallons in April 2002.³ In terms of gpm this would equate to an average of 23 gpm. And, the Bellemont area is experiencing some increasing growth with concomitant pressure on the limited groundwater availability. Thus, an increased need of 8 gpm would necessitate the addition of a new well somewhere in the project vicinity. Furthermore, since the shallow aquifer in the Bellemont area appears to be fully utilized, a deep well drilled to 1500 to 1600 feet would be necessary to access at least 10 gpm of continuously available water, according to the local office of the United States Geological Survey (USGS).⁴ To increase the chances of a well yielding sufficient water for the power plant, the USGS also suggested that the well be drilled along the Bellemont fault line which is approximately 1 mile to the east of the project site. This seismic fault line may contain fractures, which would increase permeability and deep groundwater yield. This position is somewhat supported by the fact that Camp Navajo had a deep well in the 1950's that yielded 40 to 50 gpm. It was located along the Bellemont fault line (it was abandoned in that decade due to improper well construction). If surplus water could be obtained by drilling a deep well for the power plant, there are ready customers in the area for the surplus water.

³ Nona McClain, Manager, Bellemont Water District, April 27, 2002

⁴ Don Bills, Hydrologist, USGS, Flagstaff Office, April 30, 2002 meeting

Camp Navajo is also proposing to drill a 2000 foot well, scheduled for completion in November 2002, and fully operational by June 2003.⁵ The Camp representative would not predict the actual yield of this proposed well, but stated they may sell excess water.

Wastes and Hazardous Materials

The biomass fuel will produce ash (bottom and fly) at approximately 3% of fuel volume as fed to the boiler. For example, 40,000 BDT of biomass fuel would therefore produce 1,200 tons of ash per year (approximately 3.7 tons per day of operation). Approximately 10% of the ash is fly ash. Fly ash can be used as soil amendment. Bottom ash could be used on-site or as road base material for local and regional transportation projects. However, discussions with the ADEQ Water Quality Division indicated that the use of fly and bottom ash as a product may require a permit from their office. This would have to be further reviewed by ADEQ.⁶

If no marketable use (typically this ash is prized as soil amendment or it can be used as road base material) is found or if on-site use as road base material cannot be accomplished, the ash would have to be disposed on in an appropriate landfill.

There will be some hazardous materials normally associated with power plants stored and used at the proposed power plant. These principally include anti-fouling chemicals for the process water, and anhydrous or aqueous ammonia for the NOx emissions control system.

Natural Gas Availability

As mentioned above the proposed 5 MW biomass power plant will be fueled exclusively by forest residues. Natural gas will not be used as a supplement fuel. However, there is a four inch natural gas supply line along Old Highway 66, adjacent to SCA Tissue and could be extended to the proposed power plant if necessary. Some biomass plants utilize natural gas as a supplemental fuel to facilitate start up of operations.

Electricity and Interconnection

Electricity used by the facility would be supplied in-house, except for periods of facility shutdown (scheduled maintenance) when it would be supplied by Arizona Public Service (APS). Power generated by the facility would be delivered to APS. Additional transmission lines would have to be built to service the facility, and interconnection specifications of APS would need to be adhered to.

⁵ Cullen Hollister, Post Engineer, Camp Navajo, September 4, 2002 phone conversation

⁶ Steve Miller, ADEQ Water Quality Division, May 1, 2002 meeting

Findings:

The site chosen by GFFP appears to be permit-able and any environmental impacts, such as air quality and water impacts can be mitigated in a manner that are acceptable to the regulatory agencies, citizens, communities and other stakeholders. The major issue is the use of water by a proposed biomass power plant. Projected water use is from 1.2 to 11 acre feet per year depending on the technology used in a new power plant. Water may be available from Camp Navajo, who indicated they will drill a new deep water well, and may have surplus water available for the project. At the worst economic case, a new deep water well would have to be drilled for the biomass power plant at a cost of as much as \$1million-plus.

IX. STAKEHOLDER SUPPORT/RESISTANCE

In order for a project of the type proposed for the Bellemont Area to be developed in or near a community, public support is vital. Numerous commercial scale projects have been assessed that had all of the required economic and siting issues addressed, but ultimately failed due to no community support or in some cases, active community resistance.

In order to understand the potential public support or resistance of the greater Flagstaff area for a biomass power plant at Bellemont the following stakeholders were interviewed:

- James Perkins, Owner, Perkins Timber Harvesting
- Dick Fleishman, GFFP Liaison, USDA Forest Service
- Brian Cottam, Coordinator, GFFP
- Donna Cochran, Executive Director, Williams Chamber of Commerce
- Debra Larson, Ph.D., P.E., Professor, College of Engineering and Technology, Dept. of Civil and Environmental Engineering, Northern Arizona University
- David Maurer, President, Flagstaff Chamber of Commerce
- Matthew Ryan, Supervisor, Coconino County
- Alan Bates, Chair, Prescott Area Wildland/Urban Interface Commission
- Lewis Humphreys, Vice President, Greater Flagstaff Economic Council
- Jerry Payne, Region 3 staff, USDA Forest Service

These stakeholders felt that the population in the greater Flagstaff area would support the Bellemont project based on the following prioritized sentiments:

- 1. Air Quality/View Shed Improvement** - An operating biomass plant would contribute significantly to the improvement of air quality in northern Arizona. Air quality is a top of mind issue for many northern Arizona residents primarily due to the tourism-based economy of the area (Coconino County economy is 50% to 60% tourism based per Coconino County Supervisor Ryan). Woody material (small trees and brush) that would normally be burned in the open during a wildfire or a prescribed fire (fuels treatment) could be burned under strictly controlled conditions in a biomass fired boiler that generates relatively few emissions (compared to open burning) and electricity.
- 2. Fuels Treatment Activities** – The Bellemont project may provide an alternative destination for wood waste from forest restoration activities. Fire season 2002 activities have initiated a renewed interest for pro-active

fuels treatment activities that will provide some wildfire defensible space for rural communities.

3. **Utilization of Biomass Fuel** – Biomass fuel generated as a result of forest restoration activities should be utilized for value added products.
4. **Acceptance of Industrial Site** – The industrial park at Bellemont has been selected for industrial development. This site is located 12 miles from Flagstaff at a site that is zoned for industrial development.
5. **Renewable Energy Production** – Biomass power is a renewable energy resource and as such is considered a net positive due to it's sustainable fuel source (trees are renewable), reduced emissions compared to fossil fuel fired systems, and net contribution to carbon sequestration and the reduction of green house gases.
6. **New Jobs** - Project would facilitate the creation of new, relatively high paying jobs; from technicians to operate the power plant, to workers involved in the collection, processing and transport of biomass fuel.

As with most proposed commercial scale operations, there are areas of concern that local residents will have regarding a biomass power plant. Summarized below are some of the concerns that those interviewed felt could cause some resistance to the Bellemont project:

- **Tree Removals** – Any venture that would utilize trees (even small trees) will promote the arbitrary removal of trees.
- **Water Availability** – northern Arizona is in the midst of sustained drought conditions and water is currently in scarce supply; the proposed project will negatively impact the local water resource.
- **Air and Water Impacts** – Project will negatively impact air and water quality in the Bellemont area.

Clearly the removal of trees in support of forest restoration/fuels treatment is a priority issue. Actually, the removal of trees for any purpose is a priority issue in many communities in the west. A recent survey that included Flagstaff area residents was conducted by Jeremy Delost in support of his master's thesis (Masters of Science in Forestry, Northern Arizona University). Submitted in December, 2001 and titled "*Public Attitudes Towards Forest Restoration Methods in Arizona*", the Delost thesis concluded:

“Overwhelming support was found for the use of selective thinning among wildland urban interface residents, as over 78% had a positive attitude, 20% had a cautious attitude and only 2% opposed the use of selective thinning.”

For this survey, the wildland urban interface residents were those that resided in the Flagstaff area.

Response from non-wildland urban interface residents was also quite positive regarding the use of selective thinning: 59% had a positive attitude; 38% had a cautious attitude, and; 3% opposed the use of selective thinning. For this survey, the non-wildland urban interface residents were those that resided in Arizona, outside of the Flagstaff area.

Mr. Delost's results were based upon a survey response of 464 participant responses in the form of completed surveys. The response rate for the Flagstaff area was over 62% compared with a response rate of 45% for the rest of Arizona. This appears to indicate a high level of interest regarding fuels management issues amongst Flagstaff residents.

As noted earlier, public support for the Bellemont project is essential if it is to be considered viable. From experience in developing biomass utilization plants in North America, TSS has developed the following public outreach concepts that are necessary for successful project implementation:

- Keep the public informed of the planning schedule – public hearings
- Target key stakeholder groups for more intensive discussions/field time
- Seek opportunities to solicit input/concerns regarding the project and its potential impacts
- Facilitate field trips to active fuels treatment operations
- Facilitate field trips to operating biomass power plants
- Articulate the concept that the primary objective is forest restoration and fire resiliency, not commodity production (power generation)

Findings:

From Delost's work it appears that there is significant public support for selective thinning in support of fuels treatment activities. This sentiment is supported by the results of stakeholder interviews. In fact, due to the high visibility of the current fire season, and the relative close proximity of the Rodeo-Chediski fire, public support in Arizona for fuels treatment may currently be higher than those found in Delost's work of 2000 - 2001.

X. PRELIMINARY FINANCIAL PROJECTIONS

This section reviews the project economics of a potential 5 MW biomass power plant that would be located at the Bellemont site. A financial model was developed for a 5 MW biomass power plant at the Bellemont site. The assumptions and parameters are detailed below. A base case was developed that uses current market wholesale rates and projected capital and operating costs to determine the economic viability of the potential biomass power plant.

Based on preliminary financial projections presented below and given the existing market conditions, the base case shows that a proposed biomass project is ***not*** economically viable at the Bellemont site. Further scenarios were developed and modeled to determine what changes in the market place would have to occur for a proposed biomass power plant to be viable at the Bellemont site. Four alternative financial model Scenarios (A, B, C and D) were developed, by adjusting the economic drivers to the project, i.e., capital costs, fuel costs and revenue stream.

Assumptions-Conventional Biomass Direct Fired Combustion

Plant Description assumptions are as follows:

Plant Size:	4.5 Megawatt, net; 5.0 MW, gross
Operations:	329 days per year
Fuel:	Forest residue and slash: 100% Biomass fuel
Fuel cost:	\$40/BDT
Tonnage Required:	40,000 BDT per year
On Site Fuel Storage:	4 months
Acreage:	20 acres
High Heating Value:	8,500 BTU/pound
Ash Content:	3%
Ash Disposal:	Soil amendment; cost \$10/ton for trucking
Zoning:	Industrial
Interconnection:	Arizona Public Service
Project Schedule:	6 months to permit; 12 months to construct.
Construction Jobs:	100 at peak
Operations Jobs:	15
Water Usage:	1-10 gallon per minute; 1.2-11 acre-feet per year

Project Economics

Following are summaries of the Base Case and 4 alternative financial projections for a proposed biomass plant located at Bellemont, Arizona: Base case, and scenarios A, B, C & D.

Base Case - Full Capital Costs; Full Fuel Costs; Market Energy Rates, hereafter referred to as the 3 Cent/kWh scenario.

The project economics are based on current market conditions and using conventional direct-fired combustion and related assumptions cited above. The analysis concluded that a new 5 MW biomass power plant would not be viable at the Bellemont site. The three economic drivers to the project that were analyzed include: (1) retail power rates; (2) fuel costs; and (3) capital costs. Today, the wholesale energy rates for selling electricity into the northern Arizona grid are approximately \$0.03/kWh, the biomass fuel from forest restoration activities at full cost is \$40/BDT, and capital cost for a 5 MW plant is \$15.5 million. Given these assumptions, the base case for the project would lose \$3.8 million per year, without allowing for a return for capital investment. If the costs of capital and private sector required return on investments (ROI) were included the proposed project would lose \$6.4 million per year.

Base Case - 3 Cent/kWh Scenario

Table X-1 below shows the base case for the proposed project with the assumptions cited below that reflects current market conditions for wholesale power at \$0.03/kWh. Capital Costs of \$15.5 million; fuel costs at \$40/BDT; current market energy rates of \$0.03/kWh; financing with 100% equity and a Return on Investment of 17%.

Table X-1. Base Case: 3 Cents/kWh Scenario						
Biomass Power Generation	Base Case					
Size Plant, MW, net	4.5		Parasitic Load	10%		
Fuel Blend	Biomass	100%	Natural Gas	0%	Except Startup	
Annual Energy Input, BTUs/yr	679,056,000,000					
					Op Days	329
Total net kWh per year	35,532,000		Capacity		Op hrs	7,896
Total Annual Revenues, net	\$ 1,065,960		\$ 0.0300	\$/kWh	Op %	90%
Fuel Requirements		\$/kWh, net				
Biomass BDT/yr	39,944		\$ 40.00	\$/BDT		BDT/MW
						1.12
Total Fuel Cost	1,597,779	\$ 0.045				
Labor	677,040	\$ 0.019				
Maintenance, routine & major	1,072,000	\$ 0.030				
Total Ops, exc Depreciation	758,706	\$ 0.015				
Depreciation	777,830	\$ 0.022				
Total Op Expenses	\$ 4,883,355	\$ 0.137				
Pre-Tax Net Income	\$ (3,817,395)	\$ (0.107)				
Total Capital Costs	\$ 15,556,590		\$/MW, net	\$ 3,457,020		Deprec yrs
						20
P&I Payments	\$ -	\$ -	\$ 15,556,590	years	20	int rate
						6.00%
ROI target	\$2,644,620	\$ 0.0744	ROI Target	17%	Equity	100%
Biomass Cost	\$ 40.00					
Biomass Gross Value Added	\$ 26.69					

Base Case - 3 Cents/kWh Findings:

The Base Case – 3 Cents/kWh in Table X-1. shows a net loss of \$3.8 million in year 1. The cost to operate is \$0.137/kWh, including a fuel cost of \$0.045/kWh and depreciation of \$0.022/kWh, but does not include an allowance for a return on the capital investment. In the private sector and given the relatively high risk associated with the development of this type of project, the annualized return on the capital investment requirements of \$15.5 million would require the project to earn \$2.6 million, or \$0.0744/kWh. The total projected losses incurred in this Base Case scenario are: \$6.4 million, when accounting for operation losses and a likely required market based return on investment of 17% for this type of project.

Scenario A - 22 Cents/kWh

Scenario A – 22 Cents/kWh - assumes that the capital cost and fuel cost economic drivers reflects the existing market. However, the wholesale price for selling electricity into the grid from a 5 MW biomass power plant at the Bellemont site would have to increase to \$0.22/kWh. This would provide revenues of \$7.8 million annually to meet the minimum marketplace threshold for private equity investment and debt. Coincidentally, this \$0.22/kWh rate in Scenario A is in the cost range of photovoltaic electricity produced in Arizona and elsewhere.

Table X-2. below shows the 22 Cents/kWh scenario for the proposed project. The rate per kWh is increased beyond the market prices to a level where the project meets the thresholds for financing in the private sector. The other cost assumptions remained the same as the base case: fuel costs of \$0.045/kWh (\$40/BDT) and capital costs at \$15.5 million.

**Table X-2.
Scenario A - 22 Cents/kWh**

Biomass Power Generation	Scenario A Combustion Increase \$/kWh					
Size Plant, MW, net	4.5		Parasitic Load	10%		
Fuel Blend	Biomass	100%	Natural Gas	0%	Except Startup	
Annual Energy Input, BTUs/yr	679,056,000,000					
					Op Days	329
Total net kWh per year	35,532,000		Capacity		Op hrs	7,896
Total Annual Revenues, net	\$ 7,861,455		\$ 0.2213	\$/kWh	Op %	90%
Fuel Requirements		\$/kWh, net				
Biomass BDT/yr	39,944	\$ 40.00		\$/BDT		BDT/MWh
						1.12
Total Fuel Cost	1,597,779	\$ 0.045				
Labor	677,040	\$ 0.019				
Maintenance, routine & major	1,072,000	\$ 0.030				
Total Ops, exc Depreciation	1,098,481	\$ 0.015				
Depreciation	777,830	\$ 0.022				
Total Op Expenses	\$ 5,223,129	\$ 0.147				
Pre-Tax Net Income	\$ 2,638,326	\$ 0.074				
Total Capital Costs	\$ 15,556,590		\$/MW, net	\$ 3,457,020		Deprec yrs
						20
P&I Payments	\$ -	\$ -	\$ 15,556,590	years	20	int rate
						6.00%
ROI target	\$2,644,620	\$ 0.0744	ROI Target	17%	Equity	100%
Biomass Cost	\$ 40.00					
Biomass Gross Value Added	\$ 196.81					

Scenario A – 22 Cents/kWh Findings:

Scenario A reflects that the rate for the sale of electricity must be \$0.22/kWh, yielding \$7.8 million in revenues annually to be finance-able in the private market place. This electric rate is what is necessary for the Bellemont biomass power plant to be economically viable, when the other cost assumptions are kept constant: capital costs and fuel costs.

Scenario B - 15 Cents/kWh

Scenario B uses the base case assumptions referenced above, but modified the three primary economic drivers to determine what mix would be required to make the proposed power plant viable in the marketplace: reduces the capital costs to \$7.7 million from \$15.5 million (50% reduction in capital costs assuming a 50% grant); reduces delivered fuel costs to \$12/BDT from \$40/BDT (based on annual \$28/BDT investment by land managers based on their land management objectives, reducing the delivered fuel costs to \$12/BDT) and increases revenues by increasing the power sale rates from approximately \$0.03/kWh to \$0.15/kWh yielding \$5.3 million in revenues from the current wholesale rates of. Table X-3. below shows Scenario B, with these three assumptions modified to make proposed biomass power plant economically viable.

Table X-3 Scenario B - 15 Cents/kWh						
Biomass Power Generation	Scenario B		15 cent power; \$12 fuel; 50% capital cost			
Size Plant, MW, net	4.5		Parasitic Load	10%		
Fuel Blend	Biomass	100%	Natural Gas	0%	Except Startup	
Annual Energy Input, BTUs/yr	679,056,000,000					
					Op Days	329
Total net kWh per year	35,532,000		Capacity		Op hrs	7,896
Total Annual Revenues, net	\$ 5,329,800		\$ 0.1500	\$/kWh	Op %	90%
Fuel Requirements		\$/kWh, net				
Biomass BDT/yr	39,944		\$ 12.00	\$/BDT		BDT/MWh
						1.12
Total Fuel Cost	479,334	\$ 0.013				
Labor	677,040	\$ 0.019				
Maintenance, routine & major	1,072,000	\$ 0.030				
Total Ops, exc Depreciation	971,898	\$ 0.015				
Depreciation	777,830	\$ 0.022				
Total Op Expenses	\$ 3,978,101	\$ 0.112				
Pre-Tax Net Income	\$ 1,351,699	\$ 0.038				
Total Capital Costs	\$ 15,556,590		\$/MW, net	\$ 3,457,020		Deprec yrs
With one time capital grant	\$ 7,778,295					20
P&I Payments	\$ -	\$ -	\$ 15,556,590	years	20	int rate
						6.00%
ROI target	\$1,322,310	\$ 0.0372	ROI Target	17%	Equity	100%
Biomass Cost	\$ 12.00					
Biomass Gross Value Added	\$ 133.43					

Scenario B - 15 Cents/kWh Findings:

Scenario B – 15 Cents/kWh - is an alternative that modifies the three key economic drivers: reducing the capital costs to \$7.7 million from \$15.5 million (assuming a 50% government grant); reducing fuel costs to \$12/BDT from \$40/BDT (assuming landowner investments based on their other land management objectives) and increasing electrical rates to \$0.15/kWh from the current \$0.03/kWh to yield \$5.3 million in revenues annually (assuming expanded use of the EPS for biomass).

Scenario C - 12 Cents/kWh

Table X-4. shows Scenario C – 12 Cents/kWh with cost sharing assumptions different than Scenario B, that would also allow the project to meet the minimum thresholds for financing the potential biomass power plant project.

The Scenario C alternative modifies the following economic drivers: reduces capital costs to \$3.9 million from \$15.5 million (75% reduction in capital cost); reduces fuel costs to \$4/BDT from \$40.00/BDT (90% reduction) and increases power sale rates from the current power sale rates of \$0.03/kWh to \$0.12/kWh yielding \$4.3 million in revenues.

**Table X-4.
Scenario C - 12 Cents/kWh**

Biomass Power Generation	Scenario C Combustion		12 cent power; \$4 fuel; 25% capital cost			
Size Plant, MW, net	4.5		Parasitic Load	10%		
Fuel Blend	Biomass	100%	Natural Gas	0%	Except Startup	
Annual Energy Input, BTUs/yr	679,056,000,000					
					Op Days	329
Total net kWh per year	35,532,000		Capacity		Op hrs	7,896
Total Annual Revenues, net	\$ 4,263,840		\$ 0.1200 \$/kWh		Op %	90%
Fuel Requirements		\$/kWh, net				
Biomass BDT/yr	39,944		\$ 4.00	\$/BDT to pro		BDT/MWh
				\$/BDT actual		1.12
Total Fuel Cost	159,778	\$ 0.004		\$ 40.00		
Labor	677,040	\$ 0.019		Difference \$/BDT		
Maintenance, routine & major	1,072,000	\$ 0.030		\$ 36.00		
Total Ops, exc Depreciation	918,600	\$ 0.015		Other source of funding for fuel		
Depreciation	777,830	\$ 0.022		\$ 1,438,001		
Total Op Expenses	\$ 3,605,248	\$ 0.101				
Pre-Tax Net Income	\$ 658,592	\$ 0.019				
Total Capital Costs	\$ 15,556,590		\$/MW, net	\$ 3,457,020		Deprec yrs
With one time capital grant	\$ 3,889,148					20
P&I Payments	\$ -	\$ -	\$ 15,556,590	years	20	int rate
						6.00%
ROI target	\$661,155	\$ 0.0186	ROI Target	17%	Equity	100%
Biomass Cost	\$ 4.00					
Biomass Gross Value Added	\$ 106.74					

Scenario C – 12 Cents/kWh Findings:

Scenario C reflects an alternative to modify the economic drivers: reduced capital costs to \$3.9 million from \$15.5 million; reduced fuel costs to \$4/BDT from \$40/BDT and increased electrical rates to \$0.12/kWh that would yield \$4.3 million in revenues versus the current wholesale rates of approximately \$0.03/kWh.

Scenario D - 6 Cents/kWh (Cogeneration Location)

Scenario D is an alternative that assumes selling electricity at slightly below retail rates as cogeneration to one or more nearby users, rather than selling electricity of a new biomass power plant into the electrical grid for wholesale prices. Selling cogeneration to adjacent users would likely result in an equivalent rate of approximately \$0.06/kWh for electricity, steam and/or process heat. The other economic drivers are not modified, but reflect existing markets. In this scenario, a potential biomass power plant at the Bellemont site would incur losses of \$2.8 million prior to allowing for a market based return on investment. Scenario D also reflects that including an allowance for a market based ROI (17%) that would be essential to get the project capitalized, the total project losses would be \$5.4 million per year.

Table X-5. below shows Scenario D where a cogeneration host would purchase all of the energy produced by the proposed project, assuming current retail rates of \$0.06/kWh.

**Table X-5.
Scenario D - 6 Cents/kWh**

Biomass Power Generation	Scenario D	Retail Electric Rate with equivalent steam/cogent revenue				
Size Plant, MW, net	4.5		Parasitic Load	10%		
Fuel Blend	Biomass	100%	Natural Gas	0%	Except Startup	
Annual Energy Input, BTUs/yr	679,056,000,000					
					Op Days	329
Total net kWh per year	35,532,000		Capacity		Op hrs	7,896
Total Annual Revenues, net	\$ 2,131,920		\$ 0.0600	\$/kWh	Op %	90%
Fuel Requirements		\$/kW, net				
Biomass BDT/yr	39,944		\$ 40.00	\$/BDT		BDT/MWh-n
						1.12
Total Fuel Cost	1,597,779	\$ 0.045				
Labor	677,040	\$ 0.019				
Maintenance, routine & major	1,072,000	\$ 0.030				
Total Ops, exc Depreciation	812,004	\$ 0.015				
Depreciation	777,830	\$ 0.022				
Total Op Expenses	\$ 4,936,653	\$ 0.139				
Pre-Tax Net Income	\$ (2,804,733)	\$ (0.079)				
Total Capital Costs	\$ 15,556,590		\$/MW, net	\$ 3,457,020		Deprec yrs
						20
P&I Payments	\$ -	\$ -	\$ 15,556,590	years	20	int rate
						6.00%
ROI target	\$2,644,620	\$ 0.0744	ROI Target	17%	Equity	100%
Biomass Cost	\$ 40.00					
Biomass Gross Value Added	\$ 53.37					

Scenario D - 6 Cents/kWh Findings:

Scenario D -- 6 Cents/kWh shows the impacts of modifying the power sale rates to reflect cogeneration sales to nearby government/industrial users at the Bellemont site: This scenario holds the other financial assumptions constant except the electrical sales rates are increased to \$0.06/kWh or \$2.1 million in revenues. The potential new biomass project would still incur losses of \$5.4 million/ annually, including allowing for a market-based return on investment.

This alternative reflects that the current market conditions continue: assuming conventional direct-fired combustion and other drivers, including (1) wholesale and retail power rates at \$0.03 and \$0.06/kWhr respectively; (2) fuel costs at \$40/BDT; and (3) capital costs of \$15.5 million.

Findings - All Scenarios

This analysis demonstrates that the Base Case of a 5 MW biomass power plant is not viable at the Bellemont site, given current market conditions and proposed project parameters as shown in the Base Case. Consequently, four alternative scenarios were developed to determine what changes in the economic assumptions would have to be made to have an economically viable project. Those four alternative scenarios are summarized in Table X-6. below, along with the base case.

Table X-6. Project Economics Summary		
Scenario	Parameters	Economic Viability
Base Case 3 Cents/kWh	Full Capital Costs: \$15.5 million Full Fuel Costs: \$40/BDT Market Wholesale Energy Rates: \$0.03/kWh	No
Scenario A 22 Cents/kWh	Full Capital Costs: \$15.5 million Full Fuel Costs: \$40/BDT Increased Energy Rates: \$0.22/kWh	Not Likely
Scenario B 15 Cents/kWh	50% Reduction in Capital Costs: \$7.7 million Reduction in Fuel Costs: \$12/BDT Increased Energy Rates: \$0.15/kWh	Possible
Scenario C 12 Cents/kWh	75% Reduction Capital Costs: \$3.8 million Reduced Fuel Costs: \$4/BDT Market Wholesale Energy Rates: \$0.12/kWh	Possible
Scenario D 6 Cents/kWh	Full Capital Costs: \$15.5 million Full Fuel Costs: \$40/BDT Cogen Energy Rates: \$0.06/kWh	Candidate cogeneration user not yet identified

XI. POTENTIAL FINANCING AND JOINT VENTURE PARTNERS

There is a major dichotomy in the renewable market place. Existing renewable power plants have been struggling with the fallout of electrical deregulation that favors the cheapest market sources of electricity: fossil fuels, both coal and natural gas fueled power plants. Costs of \$0.02 to \$0.04 /kWh are the range of electrical generating costs in most financial projections for new 250 to 1000+ MW coal and natural gas fueled power plants in much of the United States. Base load (electrical production 24 hours/day, 7 days/week) power from existing renewable energy electrical generation ranges from \$0.06 to \$0.10/kWh and higher for new biomass power plants, \$0.20 to \$0.30/kWh for solar, and \$0.05 to \$0.15+/kWh for wind depending on whether it's sold for base load power or for energy rates. Thus, the existing renewable electrical generators are at odds with a primary goal of electrical deregulation to reduce rates by buying from the cheapest source of electrical generation: fossil fuels.

Thus, the current electrical market structure is based on the purchase of electricity from the lowest costs generators, which are currently coal and natural gas fueled power plants. In the short term with current market conditions, renewable electrical generators have to be justified by externalizing public benefits and avoided public and private costs in the marketplace.

However, there are three factors driving the development of new renewable electrical generators in the future:

- There are growing U.S. and worldwide demands for electricity, from increasing populations and increasing per capita consumption of electricity. This is even more acute in developing nations trying to improve their quality of life by industrializing. It is also occurring in industrial countries that are increasing their use of energy to improve their productivity and decrease the costs of labor.
- There are finite fossil fuel resources. Although renewables will not replace fossil fuels, they will help meet part of the future new demand for electricity as the renewable technologies become more market efficient and the demand for diminishing fossil fuels increases their marginal costs in the market place.
- There is a national need for more domestic sources of energy to reduce dependence on foreign fossil fuel; i.e., more energy security and self-sufficiency.

In addition to the above factors and more specifically in the United States, there are additional factors driving the development of biomass power plant technologies. Biomass waste disposal costs are increasing and due to increased environmental rules and regulations, the alternatives for disposal are becoming more constrained, which also further increases the disposal costs of forest fuel, agriculture residue and urban wood

wastes. Costs are increasing in the form of growing fire suppression costs and losses, increasing agriculture residue disposal costs from more environmental constraints on open field burning of agriculture residues, and increases in tipping fees for urban wood wastes. These long-term trends are particularly important in attracting more public and private sectors investments to improve the economic efficiencies of biomass technologies. For example, if hazardous fuel can be diverted from being burned in a forest fire to becoming a raw material for a biomass power plant, the avoided costs of disposing of the hazardous fuel can be used to partially pay the delivered costs of the raw material and make a new product; renewable energy.

Possibly as a result of the above factors, a second renewable electrical industry is developing in the market place, attracting significant new private capital. During the past few years, a number of new independent renewable energy power producers have been created in Europe and the United States, with both U.S. and international renewable energy markets as their targets. These new renewable independent power producers are focusing on biomass, wind and geothermal development, with some of them also doing small natural gas fired cogeneration power plants that are sized for prisons, government facilities, shopping centers, commercial and industrial users. These new renewable energy businesses in the electrical marketplace are aggressively looking for renewable energy or cogeneration opportunities that will meet their return on investment requirements and allow building renewable portfolio assets that are viable on a long-term basis.

These new renewable electrical businesses will joint venture or take the prime developer role on new renewable electric power plants, and have the capability to bring the development, financing, construction and operations teams to develop and operate new renewable power plants.

TSS contacted two of these new companies concerning the potential Bellemont biomass power plant. Both indicated interest, but only if all of the project viability issues are positive. At this point while the fuel availability and environmental issues are positive, the financial issues are not as reflected in the financial analysis and findings. Should the financial issues change to make the project economically viable, then project developers can be recruited to develop the potential biomass project in northern Arizona.

XII. OTHER ALTERNATIVES FOR MEETING GFFP GOALS

As originally stated in Section IV - Approach, an additional project viability issue was added to this study:

Project Viability Issue # 8: Are there alternative approaches for addressing this project that would meet the GFFP objectives of forest restoration and the related public benefits?

Given the results of the base case analyses using current market conditions in northern Arizona, other solutions that could be considered for meeting the GFFP objectives include:

- GFFP could consider being a sponsor of a new demonstration biomass technology that would help commercialize one of the newer (yet commercially unproven) technologies in the market place that could use the hazardous forest fuels as a raw material. There are some promising new technologies that could create new industries using biomass fuels from forest restoration activities as raw material.

Becoming a sponsor of a new biomass demonstration facility could create a new demand for hazardous fuels at the Bellemont site and meet the GFFP objectives. If successful, this would have application for other parts of Arizona and the west, near communities that have forest conditions that are in need of forest restoration. GFFP could join other communities in the United States looking for a technology that could economically and environmentally create a new market demand for disposing of hazardous fuels.

After a review of options and alternative technologies (See Appendix 1. New Biomass Technologies) TSS concludes that biomass gasification technologies should be considered by the GFFP if it wishes to sponsor a new biomass demonstration technology.

The stage of development for demonstrating a new biomass gasification technology may be close financially to the financial Base Case in the financial projections section of this report. The main difference is that the new gasification technologies have a better opportunity to attract grant funding as a demonstration project with application throughout the west.

- GFFP could work with the APS to evaluate the alternative of co-firing an existing coal plant with biomass fuel. Extensive research and applications of co-firing coal plants with biomass fuels have been carried out and implemented, with some small plants being designed to run on coal or wood combinations.

- GFFP could evaluate the cogeneration potentials for siting a new biomass power plant adjacent to a user of electrical, steam or process heat, such as an industrial facility, large commercial facility, or government complex such as a prison or other government installation. Although actual electric market prices are complicated depending on the location, timing, availability and quality of energy, and other factors, current wholesale market rates for electricity average in the \$0.02 to \$0.03 /kWh for energy.

However, there are still significant margins between wholesale rates and the delivered prices to residences, small businesses, public agencies and industries. A quick review of Arizona's retail power rates show a retail cost to the customer range from \$0.65 to \$0.10/kWh. These retail rates indicate that there are significant margins between wholesale and retail customer rates that may offer future opportunities to provide cogeneration electricity.

For example, the highest wholesale rate for selling electricity from a new biomass power in northern Arizona averages \$0.03 cents/kWh and locating a new biomass power plant adjacent to a large commercial, industrial or government facility user could increase the power sales rates to the \$0.05 to \$0.06/kWh range. This would allow a significant reduction in current and future power rates to the user, assure a distributed source of electricity to keep the business in operation during the periods when the grid was down, and provide all the other benefits reflected in the GFFP goals. A cogeneration biomass power plant could also provide steam or surplus waste heat. Depending on the cogeneration customer business needs, further benefits could be the cost avoidance of installing or operating stand-alone steam or process heat, boilers could reduce that adjacent future capital investments, operating costs, permitting and/or fixed costs. However, without a commitment to purchase some or all of the power or energy from a potential user near the proposed Bellemont site, or looking for another site that has a thermal and or electrical demand, this alternative was not considered viable in the projected financials as developed in this assessment. Further investigation of potential users could significantly change one of the primary economic drivers: electricity sales rates and revenues.

APPENDIX 1.

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New Biomass Technologies

There are three key areas of new generation biomass commercial technologies that are becoming viable in the market place: (1) biomass to ethanol as transportation fuel, (2) biomass to biogas as a substitute or supplement to natural gas, and (3) biomass to chemicals either separately or in combination with the other two technologies. These technologies are available from a number of small development companies throughout the U. S. Following is a description of the available technologies:

1. Biomass to Ethanol - There are a few companies nation-wide that have proprietary technology for converting biomass to ethanol for the industrial markets and transportation fuel markets. Although no commercial facilities exist, there are a number of pilot facilities that have tested the technologies at engineering production scales. As a result of the technology viability, there is a market race among the companies to develop the first commercial plants. The technology is very close to being commercial in the market place.

Because of the availability of large volumes of biomass and the growing avoided costs of disposal, Western States are a target for most of the biomass to ethanol companies. In the West, there are a number of proposed biomass/ethanol projects in various stages of development.

TSS has been involved in evaluating most of the proposed Western State facilities. Based on these assessments, it is TSS's judgment that the most economic approach involves siting a proposed ethanol facility as a co-host to an existing biomass (or a natural gas or coal fired power plant). In fact, currently this may be the best viable option for making existing or new proposed power plants more economically viable in future deregulated markets, and making the ethanol facility more economically viable.

The advantages of co hosting an ethanol facility adjacent to an existing or new power plant are:

- Spreads the fixed costs of amortizing and operating both facilities.
- Provides markets for part of the power plant's electrical, waste heat and steam generation.

- Provides a reduced cost of electricity and steam for the ethanol facility.
- Depending on the biomass to ethanol technology used, lignin, a byproduct of producing ethanol in acid or enzyme processes, has characteristics of clean coal, without sulfur: 10,500 btu/lb. It can be used as a fuel in a coal, biomass or (by gasifying it) natural gas facility. *This fuel may significantly reduce the fuel costs of a power plant and the ethanol facility, and increase the boiler efficiency in the power plants, without a corresponding decrease in costs.* The result can be a more competitive bus bar electrical generating cost.
- Can qualify a biomass power plant for state or federal research and development grants.
- May generate strong citizen and local government support to keep a power plant operating and its related tax base, economic impacts and jobs in the community.
- Because the feedstock is biomass waste materials that are currently polluting the air and ground water, the regulatory agencies are usually supportive of permitting and even assisting in the development of these technologies.
- Since an existing power plant is already zoned for heavy industry, reduces the time, issues, and costs of doing Environmental Impact Reports and obtaining permits.

The emerging biomass to ethanol technology that should surface commercially during the next ten years is the use of ethanol as fuel in a Fuel Cell. At least two companies are developing Fuel Cells that can use ethanol as the fuel of choice. Looking down the road this is the next generation that could use ethanol to power vehicles and produce electricity.

2. Biomass to Biogas – Similar to ethanol, there are a few companies in the market place that have biomass to gas technologies. There are three categories of gasifiers in the market place:

- Digestive Gasifiers - A number of technologies exist that use Biogas from a digestive process and vessel, such as methane collected from landfills, agriculture wastes, and digestion of other organic materials. A number of commercial plants exist that collect methane from landfills for use as a natural gas substitute. Some commercial plants exist that use agriculture wastes such as pig and dairy cow manures. A number of pilot facilities also exist for testing newer digestive technologies on other agriculture wastes, food processing wastes, sewage sludge and urban wastes.
- Fossil Fuel Pyrolysis Gasifiers - Creating biogas from pyrolysis is an old technology used originally to make charcoal for industry, business and

home consumption. Before and during World War II, many countries including Germany, Australia and the United States used pyrolysis gasification of coal some of them were commercialized in the U.S., Europe, Central America, Australia and Asia. Large gasification units have been built and used in the coal and oil industries, to use coal as well as the less economic coal and oil wastes to produce gas that can be substituted for natural gas to produce process heat, steam and or electricity. Originally developed as an alternative to oil, they are primarily used as a waste disposal process by the oil and coal industries.

- Biomass Pyrolysis Gasifiers - Before and during World War II, experiments were conducted to use biomass in the fossil fuel gasifiers. That research continued, resulting in a number of biomass to gasification companies with proprietary pyrolysis technology to use agriculture, forest and urban biomass wastes. Today, a number of individual companies exist, most of them with prototypes or pilot facilities. One 60MW biomass gasification demonstration plant exists in Vermont, funded by the U.S. Department of Energy. Only one private company has commercial operating facilities. This company has multiple biomass facilities operating on rice hulls only as the fuel, in the US, Central America, Australia and Asia ranging from 150kw to 12 MW.

As with all biomass technologies, the best and most economical materials for gasification are those that have the highest avoided costs that can be used to subsidize or offset the costs of collection, processing and transporting the feedstock to an end user facility. In most Western states, the highest waste disposal cost materials are urban wood wastes, tires, sludge, and other combustible municipal wastes.

Like the biomass to ethanol technologies referenced above, there are similar opportunities and potential benefits to co-locating a gasification facility at an existing power plant. The benefits include:

- Providing partial or total re-powering of the power plant with biogas,
- Creating new power plant revenue streams by providing steam, process heat and/or electricity to the gasification facility,
- Improving the economic efficiency of the power plant and reducing the feedstock costs to the power plant and the gasification facility.

There is an additional opportunity with the biomass to gasification technology: a number of very large efficient combined cycle natural gas fired power plants are proposed (some of them as merchant plants) in the deregulated electrical market. They usually require air emission pollutant offset credits to be permitted. By adding a biomass to gas facility to a proposed large natural gas fired power plant, agriculture,

urban and forest biomass wastes in the area could be used as feedstock, converted to gas and used as supplemental fuel to the power plant. The advantages would be:

- Any agriculture and forest biomass materials diverted from open field burning could provide the air emission offset credits for permitting,
- Reducing air pollution could obtain regulatory agencies (such as the air quality regulators) positive support for siting the facilities.
- Other advantages would be similar to those listed in 2 above for biomass to ethanol facilities; i.e., economic development, additional tax base and jobs in the community.

The emerging biomass to gasification technology that is five to ten years away from commercialization is using biogas to directly fuel a gas turbine that generates electricity. This interesting option is at the prototype stage of commercialization, with a pilot facility as the next commercialization step in the market place. TSS has identified a couple of companies pursuing this technology in the US. Two appealing factors of using biogas to a gas turbine are:

- The smaller unit sizes, down to 30kw, that reduces the volumes needed, thereby reducing the fuel collection radius and the related transportation costs. The smaller size also expands the future market applications because of the lower volumes and the lower levels of electricity produced.
- The higher energy efficiency of directly firing a gas turbine to produce electricity, versus combusting the fuel in a boiler and creating steam to run the turbine.

Both of the above factors should reduce the bus bar electricity costs, when the technology is eventually commercialized.

3. Biomass to Chemicals – These are the newer biomass technologies in the market place, with only four companies identified by TSS with proprietary technologies for converting biomass to chemicals. Three companies are in the U.S. and one in Canada. One of the companies has a small commercial plant producing extractives from softwoods. Despite their relatively newness in the market place, in the long run, the biomass to chemical technologies have the most potential for producing thousands of different future chemical products from biomass waste materials.

In practice, these chemical technologies and the ethanol technologies are overlapping. The chemical technologies can produce ethanol and other gasoline additives or substitutes. The ethanol technologies produce some chemical byproducts that have markets beyond the transportation fuels. And one of the biomass to chemical companies formed a joint venture with one of the biomass to ethanol companies to produce ethanol and industrial chemicals.

The industrial chemical companies are beginning to take these new technologies seriously. These emerging technologies offer a new raw material source to chemical companies for part of their products. Making chemicals from biomass wastes also can provide a more environmentally benign image for an industry that is under heavy governmental, environmental and public scrutiny for adverse environmental impacts. A likely future alliance may be the agriculture chemical companies connecting with a biomass to chemical technology that uses agriculture wastes as a feedstock to produce agriculture chemicals.

Similar to the biomass to ethanol and gasification described in 1 and 2 above, a biomass to chemical facility could offer most of the same advantages, including co hosting with an existing SO₄ facility to make both facilities more profitable.

COMMERCIALIZATION OF BIOMASS ENERGY TECHNOLOGIES

Commercialization of new technologies usually moves through the following stages:

1. Concept development, documentation and peer reviews.
2. Laboratory bench or empirical testing to prove the basic technology processes work.
3. Build and test a prototype that produces market specification products.
4. Engineering scale pilot plant; typically scaled at 1/100 to 1/1000 of a full-scale commercial facility and does continuous production runs at an engineering scale.
5. First commercial facility produces products at a profit.
6. Multiple commercial facilities at different locations.

All technologies can be classified in one of these stages. It is not uncommon with new and existing technologies to have different companies with varying proprietary technologies produce the same product, but in different stages of commercialization. Modifications to existing technologies also go through the same development/commercialization process.

The investments to move a technology from the concept stage to full commercialization are often referred to as development capital. Development capital is high-risk monies. The risk is that the technology will actually be operating in a profitable commercial facility that creates a future revenue stream and allows the investor to recover the development capital.

The risk of development capital recovery decreases as the technology moves closer to the multiple commercial facilities stage. In other words, a dollar invested to move the technology from the laboratory test stage to the prototype testing stage is higher risk than a dollar invested to move the technology from the first commercial facility to the multiple commercial facility stage.

Keep in mind that the market place rewards two things: adding value and taking risks. The development capital investor must be convinced that the technology will add enough value to displace some other company's market share; i.e., produce a product that is cheaper or adds more value at the same price. Secondly, the investor must also be convinced that the market share and margin of the proposed product will return the development capital and a return on that investment. Thirdly, a highly successful investor knows that only one in ten will be very successful in the marketplace, at best four or five new technologies will recover the development capital and the remainder will be lost. Thus a development capital investor must also recover the development capital on the failed technologies, from the 10% that are very profitable.

The varying development capital risk of moving technologies through each successive commercialization stage is also reflected in the expected return for development capital at each stage. For example, an investor at the laboratory test stage would expect to receive a multiple return (3 times to 100 times the original investment, usually returned as profit), if the technology eventually profitably enters the market place and repays the investment. On the other hand an investment to build the second commercial facility may only return a fraction of the investment (in the 1.15 times to 3 times the original investment, usually returned as interest on debt).

With this framework of commercialization and development capital required risks, the following chart summarizes TSS's assessment of the biomass to energy technologies referenced earlier in this paper.

**COMMERCIALIZATION STAGE OF BIOMASS TO ENERGY
TECHNOLOGIES**

BIOMASS TECHNOLOGY	COMMERCIALIZATION STAGE	PROPOSED CALIFORNIA PROJECTS
Ethanol		
Sugar Separation/Distillation	Multiple Pilot Plants	A number of projects under development.
Fuel Cell Using Ethanol	Prototypes	None.
Syngas/Catalyst Process	Pilot Plants	One
Electricity Gasification		
Digester Technology	Multiple Commercial Facilities	A few projects in California and U.S.
Pyrolysis - Fossil Fuels	Multiple Commercial Facilities	Unaware of any in the developmental stage.
Pyrolysis - Biomass/boiler Technology	Multiple Commercial Facilities	Unaware of any in the developmental stage.
Pyrolysis - Biomass/turbine Technology	Prototypes	Some pilot projects are proposed.
Electricity		
Small biomass combustors	Existing commercial facilities	A few proposed in California.
Combined biomass/natural gas	Number of existing commercial facilities	One new one proposed in California.
Co-firing with biomass/coal	Existing commercial facilities	Unaware of any in the developmental stage.
Chemicals	Two commercial facilities in Canada	Two projects in early feasibility stages

APPENDIX 2.

Preliminary Assessment Questions for Biomass Energy Feasibility Study

Land Use

Is existing use consistent or complementary to that of a power plant?
What are the zoning restrictions, and if limiting can they be changed in favor of a plant?
30-40 acres required

Transportation

Will the site and surrounding highway/road system infrastructure support additional traffic, particularly semi-truck traffic (for example, a 10MW plant may have deliveries of approximately 25+ truck loads per day)?
What is the distance to the primary raw material source (forest)? Are there other green waste supplies and what is their distance to the plant? Delivery distances under 75 miles are preferred.
Railroad spur for biomass delivery?
Interstate access for biomass delivery?
Thru-town haul distance?

Air Quality Standards (may require independent research)

What are the emission limits (on an annual basis) for the air shed(s) in question?
What are the view-shed impacts (both for physical facilities and visual air shed impacts)?

Biological Resources

Endangered species issues?

Hazardous Material Management

Does the site have any existing HM issues/regulations?

Noise/Vibration Impacts

What are the noise level restrictions for both delivery of material and plant operations?

Socio-Economic Resources

Are there any business enterprise zone tax incentives or other federal and/or state tax incentives?

Is their local community support—or at least lack of opposition?

What partner and/or operator possibilities are there?

Public Health and Safety

Is the site near residential areas where fugitive emissions (e.g., dust from ash, wood, road) could be an issue?

Solid Waste

What is the local opportunity to utilize the wood ash (soil amendment, etc.)?

Where will solid waste, if not utilized, be disposed of?

Waste Water

Is there an existing water treatment facility nearby (to process blow down effluent water)?

Is there enough water available to operate a plant?

Water Resources

What are the local storm water discharge issues?

Are wetlands or other sensitive/protected sites an issue?

(Water usage for the 12MW plant at Westwood, CA (Mt Lassen Power) is:
195 gal/minute - cooling tower, 10-15 gal/minute - boiler water make up and domestic use- toilet, drinking water; 205 - 210 gal/min total)

Geology/Soils

Will the local geology/soil conditions support a facility?

Need an overall summary of the basic geology of the site (for example, if the site has sandy soils, there may be some issues about compaction and seismic risk).

Cultural Resources

Are there any archeological site or other cultural resource issues?

Has there been a recent archeological survey?

Power

Is there a local demand for this power?

Is there a feasible connection to the power grid?

APPENDIX 3.

NORTHERN ARIZONA FOREST PRODUCTS OPERATIONS - SUMMARY OF FIBER BY-PRODUCTS PRODUCED

FACILITY	LOCATION	DISTANCE	HAUL	WOOD RESIDUAL VOLUMES-OUTPUT			
		ONE WAY (miles)	COST (\$/BDT)	GREEN TONS PER DAY (ONE SHIFT)	CHIPS	SAWDUST	BARK SHAVINGS
Precision Pine	Heber, AZ	146	\$24.71	48	20	14	9
Southwest Forest Products	Phoenix, AZ	152	\$25.72	180 to 200GT produced. All residuals sold into soil amendment markets.			
Precision Pine	Globe, AZ	240	\$40.62	Not currently operating. May be operational October, 2002.			
White Mountain Apache	Cibecue, AZ	192	\$32.49	Information on residual outputs and current market values were not available.			
White Mountain Apache	White River, AZ	198	\$33.51	Information on residual outputs and current market values were not available.			

Assumptions:

1. Haul cost is rated at \$1.10/mile (\$55/hour/50mph).
2. Biomass/hog fuel moisture content is 50%.
3. Average volume per load is 13BDT.

Other:

BDT = bone dry ton (2,000 dry pounds)
 GT = green tons (2,000 pounds - as is)
 FOB SAWMILL = freight on board truck at the sawmill.